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CONSTRUCTION & OFFICE
STANDARDS

STATE HIGHWAY COMMISSION
OF MONTANA

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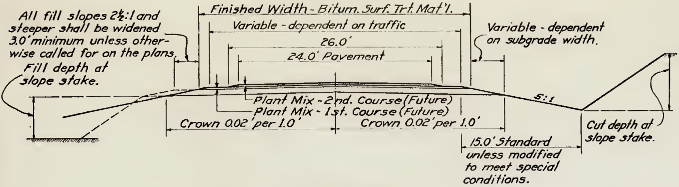
DESIGN STANDARDS

TYPICAL SECTION


Finished Width - Bitum. Surf. Trt. Mat'l.
Variable - dependent on traffic
26.0'
24.0' Pavement
All fill slopes 2½:1 and steeper shall be widened 3.0' minimum unless otherwise called for on the plans.
Variable - dependent on subgrade width.
Fill depth at slope stake.
Plant Mix - 2nd. Course (Future)
Plant Mix - 1st. Course (Future)
Crown 0.02' per 1.0'
Crown 0.02' per 1.0'
5:1
Cut depth at slope stake.
15.0' Standard unless modified to meet special conditions.

CUT SLOPES *

Cut Depth at Slope Stake	Level Terrain Design Speed 70 m.p.h.	Rolling Terrain Design Speed 60 m.p.h.	Mountain. Terrain Design Speed 50 m.p.h.	Solid Rock
0 - 5'	5 : 1	5 : 1	5 : 1	
5' - 10'	4 : 1	4 : 1	3 : 1	
10' - 15'	3 : 1	3 : 1	2 : 1	½ : 1
15' - 20'	2 : 1	2 : 1	1½ : 1	½ : 1
Over 20'	1½ : 1	1½ : 1	1 : 1	½ : 1

*-Cut slopes to be uniform through each individual cut. See Standard 206-G6 for backslope rounding.

FILL SLOPES

Fill Depth at Slope Stake	Level Terrain Design Speed 70 m.p.h.	Rolling Terrain Design Speed 60 m.p.h.	Mountain. Terrain Design Speed 50 m.p.h.	Rock
0 - 5'	5 : 1	5 : 1	5 : 1	
5' - 10'	4 : 1	3 : 1	2½ : 1	
10' - 15'	3 : 1	2½ : 1	2 : 1	1½ : 1
15' - 20'	2 : 1	2 : 1	1½ : 1 *	1½ : 1
Over 20'	1½ : 1 *	1½ : 1 *	1½ : 1 *	1½ : 1

*- Use 2:1 slopes for clay and silty soils. Widen as shown on typical section.

MINIMUM VERTICAL CURVE LENGTHS *

Type of Vertical Curve	Level Terrain Design Speed 70 m.p.h.	Rolling Terrain Design Speed 60 m.p.h.	Mountain. Terrain Design Speed 50 m.p.h.	Special Design ⊕ Design Speed 40 m.p.h.
Crest	2.5	2.0	1.5	1.0
Sag	1.5	1.0	1.0	1.0

*- Values given are the rate of vertical curvature length in stations per percent change of algebraic difference and give slighly more than non-passing sight distance.

⊕- Special design where 50 m.p.h. design speed is not possible.

MAXIMUM GRADES & HORIZONTAL CURVES

	Level Terrain Design Speed 70 m.p.h.	Rolling Terrain Design Speed 60 m.p.h.	Mountain. Terrain Design Speed 50 m.p.h.	Special Design ⊕ Design Speed 40 m.p.h.
Maximum Grade	3%	5%	6%	7%
Max. Horiz. Curve	3°30'	5°00'	7°30'	12°30'

⊕ -Special design where 50 m.p.h. design speed is not possible.

ROADWAY WIDTHS

Traffic Volume ADT *	Pavement Width (feet)	Finished Shoulders (feet)	Remarks
0 - 100	24.0	24.0	
100 - 1000	24.0	28.0 ⊕	Min. Primary - 28.0' Fin. Shldr.
1000 - 2500	24.0	32.0 ⊕	
2500 - 4000	24.0	36.0 ⊕	
Over 4000	Spec. Design	Spec. Design ⊕	
2-Lane Interstate	Spec. Design	44.0 ⊕	Except Mountainous - 32.0' Fin. Shldr.

*- In some cases, traffic volume may be given as Design Hourly Volume (DHV). In such cases, DHV × 7 = ADT.

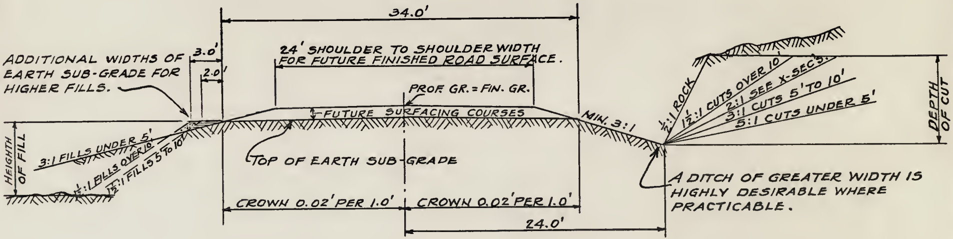
⊕- Full width prime, seal and cover material.

APPROVED 4-16-56
Scott P. Hart
STATE HIGHWAY ENGINEER

4-16-56
REV. 10-5-56

MONTANA STATE HIGHWAY COMMISSION.

SPECIAL TYPICAL SECTION OF EARTH GRADE SHOWING MINIMUM STANDARDS TO BE FOLLOWED BY COUNTY FORCES WHEN BUILDING ROADS ON FEDERAL AID SECONDARY HIGHWAY SYSTEM FOR LATER GRAVEL AND/OR BITUMINOUS SURFACING WITH FEDERAL AID.



NOTE 1:- The normal depth of future surfacing courses is 12" or more. Where the subgrade soil is of an inferior quality, or where high water table conditions dictate a deeper depth of future surfacing courses, the earth subgrade as constructed by county forces should be widened 20" over that shown above, for each 2 inches of surfacing course depths determined or estimated to be needed in excess of 12 inches. This additional width will provide for 5:1 slopes for the surfacing courses as required.

NOTE 2:- For those secondary roads which, according to the estimates of the State Highway Commission Planning Survey, will carry in excess of 100 vehicles per day the earth sub-grade width as constructed by county forces, should be that shown below.

AVERAGE DAILY TRAFFIC	SUB-GRADE WIDTH
100 TO 1000	38
1000 TO 2500	42
2500 TO 4000	46

Montana State Hwy. Commission.

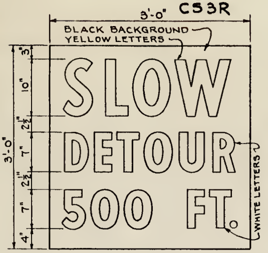
May 22, 1956
DATE APPROVED
Scott P. Hart
STATE HIGHWAY ENGINEER

A2
DS

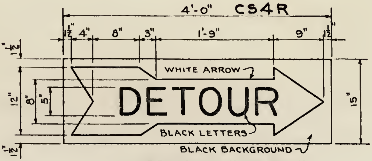
5-21-56

REFLECTORIZED CONSTRUCTION SIGNS

CS 1,2,3&4(R)



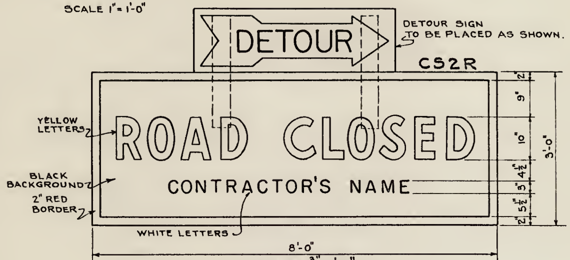
SCALE 1" = 1'-0"



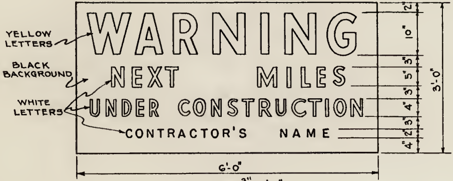
ARROW FOR DETOUR RIGHT

USE WITH REVERSE ARROW FOR DETOUR LEFT.

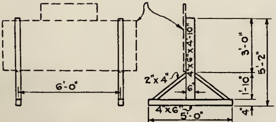
SCALE 1" = 1'-0"



SCALE ¾" = 1'-0"



SCALE ¾" = 1'-0"



PORTABLE SUPPORTS FOR ROAD CLOSED SIGN

SCALE 1/4" = 1'-0"

NOTE:- SIGNS TO BE FURNISHED AND ERECTED BY THE CONTRACTOR. SIGNS TO BE CONSTRUCTED OF 3/4" WATERPROOF PLYWOOD OR OTHER MATERIAL THAT WILL SATISFACTORILY WITHSTAND THE WEATHER. EITHER THE BACKGROUND OR LETTERS SHALL BE REFLECTORIZED {WIDE ANGLE} SIGNS TO BE FASTENED SECURELY TO 4"x4" POSTS SET AT LEAST 3'-0" IN THE GROUND AND TAMPED. CENTER OF SIGN TO BE 3.5' ABOVE GROUND. THE ROAD CLOSED SIGN MAY, AT THE CONTRACTORS OPTION, BE FASTENED TO 4"x4" POSTS AS SPECIFIED ABOVE OR MOUNTED ON THE PORTABLE SUPPORTS AS DETAILED AT LEFT. SUPPORTS TO BE SECURELY ANCHORED OR WEIGHTED DOWN.
THE LOCATION TO BE DETERMINED BY THE ENG'R.

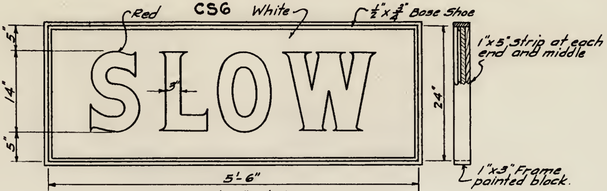
Montana State Highway Commission.

APPROVED Jan. 1, 1956

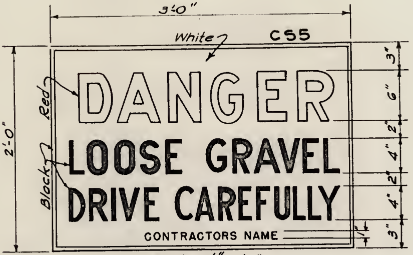
STATE HIGHWAY ENGINEER

REFLECTORIZED CONSTRUCTION SIGNS

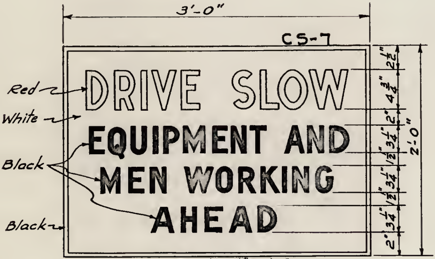
CS-5,6 & 7


CS6
Red
White
1/2" x 3/4" Base Shoe
SLOW
5"
14"
3"
5"
24"
1"x5" strip at each end and middle
1"x3" Frame painted block.
5'-6"

Scale 1" = 1'-0"



Scale 1 1/2" = 1'-0"



Scale 1 1/2" = 1'-0"

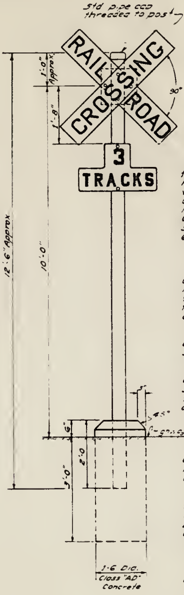
NOTE:- SIGNS TO BE FURNISHED AND ERECTED BY THE CONTRACTOR. SIGNS TO BE CONSTRUCTED OF 3/4" WATERPROOF PLYWOOD OR OTHER MATERIAL THAT WILL SATISFACTORILY WITHSTAND THE WEATHER. EITHER THE BACKGROUND OR LETTERS SHALL BE REFLECTORIZED (WIDE ANGLE). SIGNS TO BE FASTENED SECURELY TO 4"x4" POSTS SET AT LEAST 3'-0" IN THE GROUND AND TAMPED. CENTER OF SIGN TO BE 3.5' ABOVE GROUND. THE LOCATIONS TO BE DETERMINED BY THE ENGINEER.

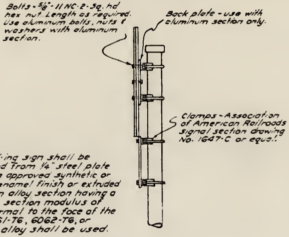
APPROVED Jan. 1, 1956
Scott P. Hart
STATE HIGHWAY ENGINEER

Montana State Highway Commission

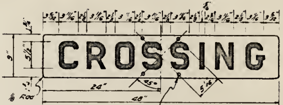
REV. 10-1-51

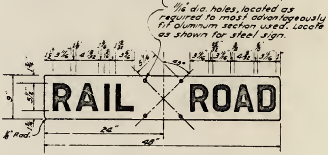
90° REFLECTORIZED R. R. CROSSING PROTECTIVE SIGNS



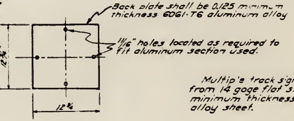

Bolts - 5/8"-11 NC-2-Sq. hd hex nut. Length as required. Use aluminum bolts, nuts & washers with aluminum section.
Back plate - use with aluminum section only.
Clamps - Association of American Railroads signal section drawing No. 1647-C or equal.

R. R. X-ing sign shall be fabricated from 1/4" steel plate having an approved synthetic or vitreous enamel finish or extruded aluminum alloy section having a minimum section modulus of 0.074 normal to the face of the sign. 6061-T6, 6062-T6, or 6063-T6 alloy shall be used.




11/16" dia. holes, located as required to most advantageously fit aluminum section used. Locate as shown for steel sign.
RAIL
ROAD
9"
5¼"
45°
24"
48"
⅛" Rad.

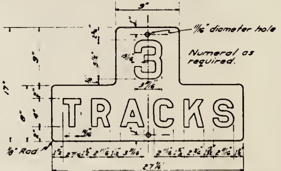
Post - 4" dia. × approx. 12'-6" galv. wrought iron or steel or black iron pipe weighing a minimum of 10 lbs. per lin. ft. If black iron pipe is used, pipe, clamps, & caps shall be painted one shop coat red lead, one first field coat red lead and one final coat of aluminum.


Back plate shall be 0.125 minimum thickness 6061-T6 aluminum alloy
11/16" holes located as required to fit aluminum section used.
12¾"
12¾

Aluminum signs, if used, shall be degreased and etched to provide proper adhesion for reflective sheeting without further treatment.

Reflectorization shall be accomplished by means of approved wide angle reflective sheeting. Crossbucks shall be white or silver with black letters. Multiple track sign shall be black with white or silver numerals and lettering.

Multiple track sign shall be fabricated from 14 gage flat steel or 0.081 inch minimum thickness 6061-T6 aluminum alloy sheet.



Sign shall be located not more than 15 ft. from center line of track and shall not be less than 6 ft. nor more than 10 ft. from the near edge of pavement or traveled way unless local conditions require otherwise.

Sign, indicating number of tracks, shall be used where there are two or more tracks. The number displayed on the sign shall be the total number crossed, including sidings. The distance that shall be assumed to separate tracks before an additional crossing sign is considered, is 100 ft. unless local conditions require otherwise.

Height of sign may be varied as required by local conditions.

The accepted quantities of this item shall be paid for at the contract unit price each for reflectorized railroad crossing sign, complete in place, which price shall be payment in full for furnishing and placing all materials, including numeral track sign and all labor, tools, equipment, supplies and incidentals necessary to complete the item.

Montana State Highway Commission

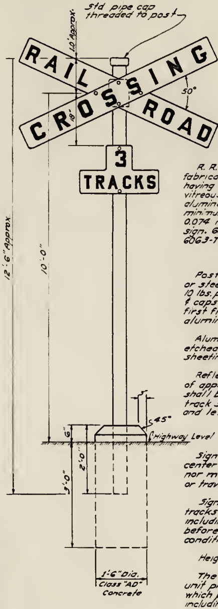
Rev. 1-1-56

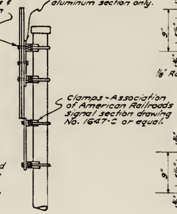
APPROVED Jan. 1, 1956
Scott P. Hart
STATE HIGHWAY ENGINEER

RCS-3

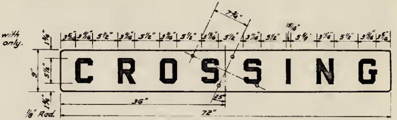
3

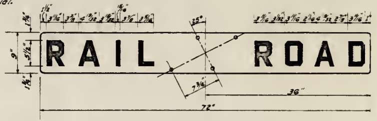
50° REFLECTORIZED R. R. CROSSING PROTECTIVE SIGNS




Bolts - 5/8" - 11 NC-2-Sq. hd hex nut. Length as required. Use aluminum bolts, nuts & washers with aluminum section.
Back plate - use with aluminum section only.
Clamps - Association of American Railroads signal section drawing No. 1647-C or equal.

R. R. X-ing sign shall be fabricated from 1/4" steel plate having an approved synthetic or vitreous enamel finish or extruded aluminum alloy section having a minimum section modulus of 0.074 normal to the face of the sign. 6061-T6, 6062-T6, or 6063-T6 alloy shall be used.

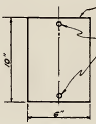




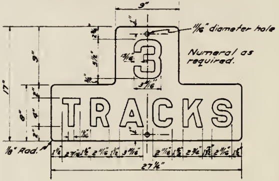
Post - 4" dia. × approx. 12'-6" galv. wrought iron or steel or black iron pipe weighing a minimum of 10 lbs. per lin. ft. If black iron pipe is used, pipe, clamps, & caps shall be painted one shop coat red lead, one first field coat red lead and one final coat of aluminum.

Aluminum signs, if used, shall be degreased and etched to provide proper adhesion for reflective sheeting without further treatment.

Reflectorization shall be accomplished by means of approved wide angle reflective sheeting. Crossbucks shall be white or silver with black letters. Multiple track sign shall be black with white or silver numerals and lettering.


Back plate shall be 0.125 minimum thickness 6061-T6 aluminum alloy.
11/16" holes located as required to fit aluminum section used.
10"
6"

Multiple track sign shall be fabricated from 14 gage flat steel or 0.081 inch minimum thickness 6061-T6 aluminum alloy sheet.



Sign shall be located not more than 15 ft. from center line of track and shall not be less than 6 ft. nor more than 10 ft. from the near edge of pavement or traveled way unless local conditions require otherwise.

Sign, indicating number of tracks, shall be used where there are two or more tracks. The number displayed on the sign shall be the total number crossed, including sidings. The distance that shall be assumed to separate tracks before an additional crossing sign is considered, is 100 ft. unless local conditions require otherwise.

Height of sign may be varied as required by local conditions.

The accepted quantities of this item shall be paid for at the contract unit price each for reflectorized railroad crossing sign, complete in place, which price shall be payment in full for furnishing and placing all materials, including numeral track sign and all labor, tools, equipment, supplies and incidentals necessary to complete the item.

Montana State Highway Commission

APPROVED Jan. 1 1956
STATE HIGHWAY ENGINEER

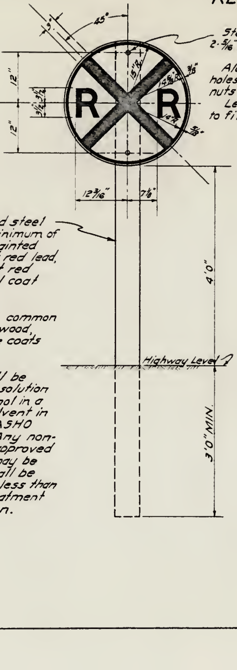
Rev. 1-1-56

RC52

4

Montana State Highway Commission

REFLECTORIZED R. R. ADVANCE WARNING SIGNS



Steel sign - 3/8" dia. holes 2-5/16" galv. bolts, nuts & washers.
- or -
Aluminum sign - 3/8" dia. holes, 2-5/16" aluminum bolts, nuts & washers.

Length of bolts, as req'd. to fit post used.

U-Type approved steel post weighing a minimum of 2½ lbs. per lin. ft., painted with one shop coat red lead, one first field coat red lead and one final coat aluminum.
- or -
4"×4", S4S, No. 1 common treated fir or larchwood, painted with three coats white lead.

Wood posts shall be treated with a 5% solution of pentachlorophenol in a light petroleum solvent in accordance with AASHO Spec. M-133-54. Any non-pressure method approved by the engineer may be used. Painting shall be accomplished not less than two weeks after treatment and prior to erection.

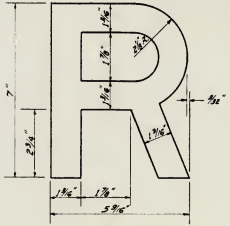
R. R. advance warning sign shall be fabricated from 16 ga. sheet steel having either a synthetic enamel or a vitreous enamel finish or may be fabricated from 0.081 minimum thickness, 6061-T6 aluminum sheet.

Aluminum shall be degreased and etched to provide proper adhesion for reflectorized sheeting without further treatment.

R. R. advance warning sign shall be placed at a slight angle toward the road, at a point not less than 6' nor more than 10' from the edge of pavement or traveled way, unless local conditions require otherwise, with the lowest edge of sign 4' above the road surface and a minimum of 100' and a maximum of 500' from the crossing or as directed by the engineer.

Background - highway yellow. Border, symbol and lettering - black.

Reflectorizion shall be accomplished by means of approved wide angle reflecting sheeting.



DETAIL OF LETTER

The accepted quantities of this item shall be paid for at the contract unit price each for advance warning sign, which price shall be payment in full for furnishing and placing all materials, labor, equipment, tools, supplies and incidentals necessary to complete the item.

APPROVED Jan. 1, 1956
STATE HIGHWAY ENGINEER

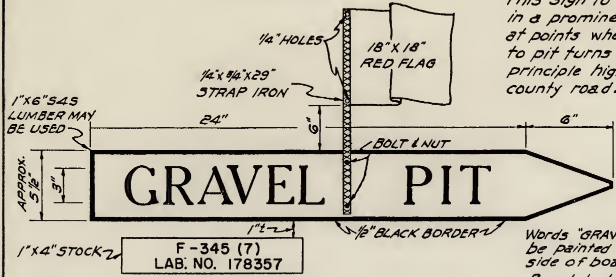
REV.-1-1-56

RCS-1

GRAVEL PIT SIGN

6 GPS

This sign to be placed in a prominent position at points where route to pit turns off from principle highway or county road.



Words "GRAVEL PIT" to be painted on each side of board.

Board to be painted "HIGHWAY RED" with BLACK letters.

This sign to be suspended from 6"x30" sign by any convenient method, noting that it may be used only once. Board need not be painted.

Letters 1" high, BLACK.

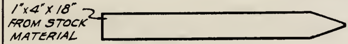
Project number and first of pit laboratory numbers to be used.

If a maintenance stockpile, use contract number instead of project number.

This sign to be placed on a gate or fence post, or fastened to a steel post, whichever is most suitabe.

If to be fastened to fence post a methed should be contrived that will not preclude continued use of the sign.

ROUTE MARKER



To be painted "HIGHWAY RED" both sides with 1/2" BLACK border. The route markers should be constructed for reuse.

These markers to be placed along the route from the "GRAVEL PIT" sign to the gravel pit, being so located that route will be clearly defined.

MARKINGS AT PIT

The gravel pit should be marked and signed in accord with any current instructions. In general, the boundary of the pit should be well marked by lath and RED flags. Test holes should be marked by stakes ~ showing depth of overburden and gravel.

APPROVED Jan. 1, 1956
Scott P. Hart
STATE HIGHWAY ENGINEER

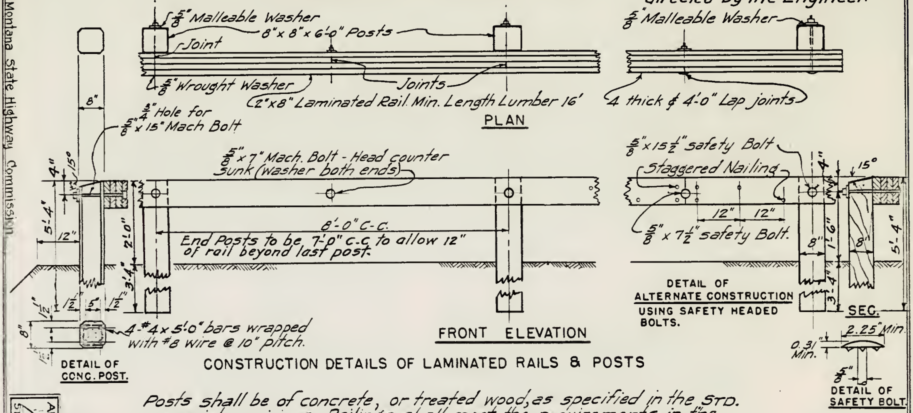
Montana Highway Commision

REV. 1-1-56

Montana State Highway Commission

LAMINATED WOOD GUARD RAIL

End post shall be offset as directed by the Engineer.


5/8" Malleable Washer
8"x 8"x 6'-0" Posts
Joint
Joints
5/8" Wrought Washer
2"x8" Laminated Rail. Min. Length Lumber 16'
PLAN
5/8" Malleable Washer
4 thick & 4'-0" Lap joints
8"
3/4" Hole for 5/8" x 15" Mach Bolt
5/8" x 7" Mach. Bolt - Head counter sunk (washer both ends)
4"
15°
5'-4"
12"
2'-0"
3'-4"
8'-0" C-C.
End Posts to be 7'-0" c.c to allow 12" of rail beyond last post.
1 1/2"
5"
1 1/2"
8"
4-#4 x 5'-0" bars wrapped with #8 wire @ 10" pitch.
DETAIL OF CONC. POST.
FRONT ELEVATION
5/8" x 15 1/2" safety Bolt
Staggered Nailing
12"
12"
5/8" x 7 1/2" safety Bolt.
8"
1'-6"
3'-4"
4"
15°
8"
5'-4"
DETAIL OF ALTERNATE CONSTRUCTION USING SAFETY HEADED BOLTS.
SEC.
2.25" Min.
0.31" Min.
5/8"
DETAIL OF SAFETY BOLT.

CONSTRUCTION DETAILS OF LAMINATED RAILS & POSTS

Posts shall be of concrete, or treated wood, as specified in the STD. specs. or special provisions. Railings shall meet the requirements in the standard specifications. or Special Provisions.

PAINT — Railings & Posts shall be painted in accordance with the standard specifications. Painting of concrete posts will not be required. End panels to be flared as directed by the Engineer. All hardware except nails to be galvanized. Nail 1st. plank to post (where wood posts are used) with 40d. nails, 2nd. plank to 1st. with 10d. nails, 3rd. to 2nd. with 20d. nails - 4th. to 3rd. with 40d. nails. Nailing to be on 2 ft. centers staggered top and bottom 2" inside of edge with joints nailed top & bottom.

NOTE — Painting, Nailing etc. & all dimensions same for either alternate (where wood posts are used.)

This sheet for historical reference only. Not to be used for design.

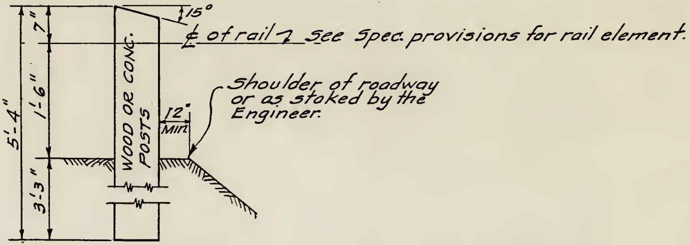
APPROVED JAN. 1, 1956
STATE HIGHWAY ENGINEER

REV. 10-1-51
REV. 6-17-53
REV. 1-1-54
REV-10-5-56

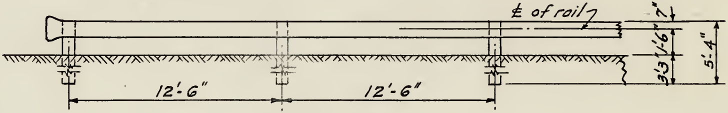
GR1

11

STEEL GUARD RAIL


15°
℄ of rail
See Spec. provisions for rail element.
Shoulder of roadway or as staked by the Engineer.
12" MIN.
WOOD OR CONC. POSTS
7"
1'-6"
5'-4"
3'-3"

NOTE:- See plans for type of posts.
For wood or conc. guard rail posts see Std. No. 11 GR1.
Concrete posts shall be cast with holes to fasten the type of rail to be used.



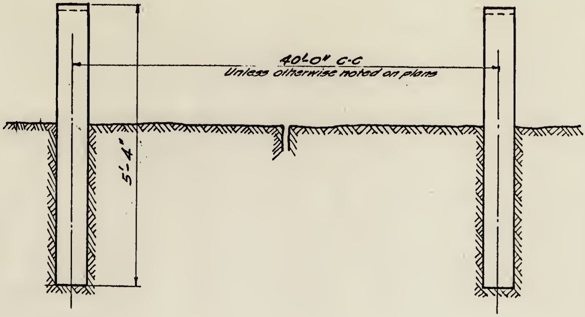
ELEVATION

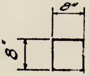
APPROVED Jan. 1, 1936
STATE HIGHWAY ENGINEER
REV. 6-17-53
REV. 1-1-56

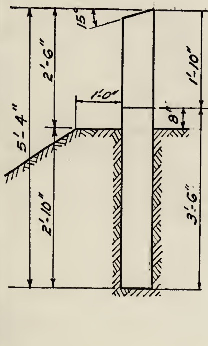
GR2

GP 2

DETAIL OF WOOD GUIDE POSTS







POSTS - Shall be treated wood as called for in the Special Provisions.

LUMBER - to meet the requirements for Posts in the Standard Specifications.

PAINT - Posts shall first be painted with 3-coats of approved black paint from bottom to a point 8" above ground line. From this point to top of post paint with 3-coats of approved white paint.

NOTE - On all projects Guide posts to be reflectorized by State forces.

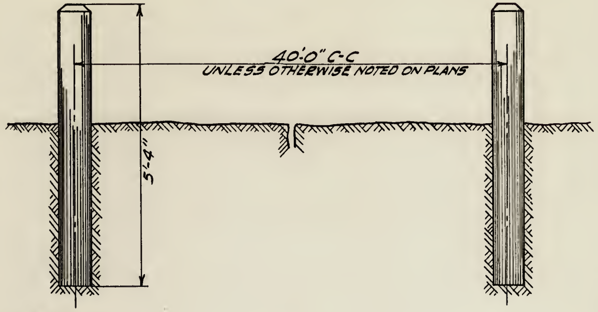
APPROVED Jan. 1, 1956
Scott P. Hart
STATE HIGHWAY ENGINEER

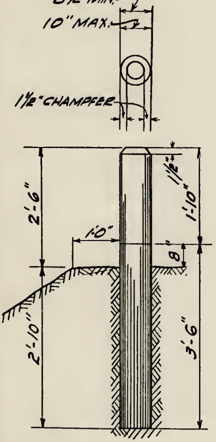
Montana State Highway Commission.

REV. 1-1-56
REV. 10-1-51
REV. 10-8-53

GP4

ROUND WOOD GUIDE POSTS





POSTS MAY BE OF DOUGLAS FIR, PONDEROSA PINE, NORTHERN WHITE CEDAR, WESTERN RED CEDAR, LARCH OR LODGEPOLE PINE. POSTS SHALL BE STRAIGHT, SOUND, AND FREE FROM DEFECTS OF ALL KINDS, AND SHALL BE CUT FROM LIVE TREES NOT LESS THAN 30 DAYS, NOR MORE THAN 1 YEAR IN ADVANCE OF USE. ALL BARK SHALL BE PEELED AND THE POSTS TRIMMED SMOOTH OF ALL KNOTS AND PROJECTIONS.

POSTS SHALL BE TREATED WOOD AS CALLED FOR IN SPECIAL PROVISIONS.

POSTS SHALL FIRST BE PAINTED WITH 3 COATS OF APPROVED BLACK PAINT FROM BOTTOM TO A POINT 8" ABOVE GROUND. FROM THIS POINT TO TOP OF POST PAINT WITH 3 COATS OF APPROVED WHITE PAINT.

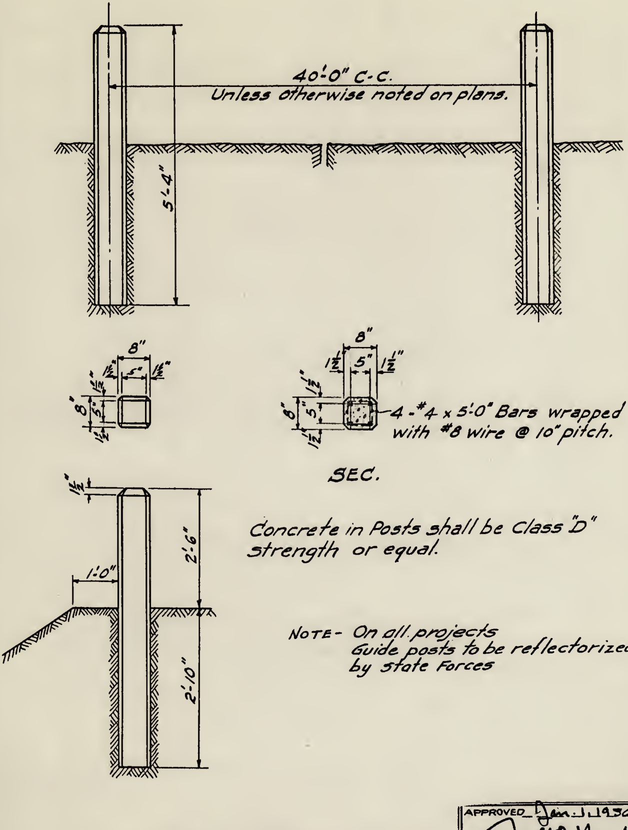
NOTE – On all projects – Guide posts to be reflectorized by state forces.

MONTANA STATE HIGHWAY COMMISSION

APPROVED Jan. 1, 1956
Scott P. Hart
STATE HIGHWAY ENGINEER

REV. 10-1-51
REV. 1-1-56

DETAIL OF CONCRETE GUIDE POSTS



4-#4 x 5'-0" Bars wrapped with #8 wire @ 10" pitch.

Concrete in Posts shall be Class "D" strength or equal.

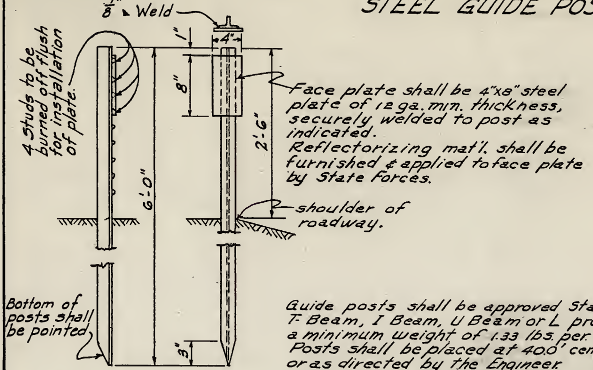
NOTE- On all projects Guide posts to be reflectorized by State Forces

APPROVED Jan. 1 1956
Scott P. Hart
STATE HIGHWAY ENGINEER

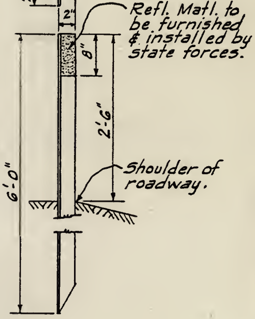
Montana State Highway Commission

REV. 10-1-51
REV. 1-1-56

STEEL GUIDE POSTS


1/8" Weld
4 Studs to be burned off flush for installation of plate.
1"
4"
8"
2'-6"
6'-0"
shoulder of roadway.
Bottom of posts shall be pointed.
3"

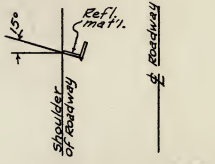
Face plate shall be 4"x8" steel plate of 12 ga. min. thickness, securely welded to post as indicated.
Reflectorizing mat'l. shall be furnished & applied to face plate by State Forces.



Guide posts shall be approved Standard T-Beam, I Beam, U Beam or L providing a minimum weight of 1.33 lbs. per lin. foot. Posts shall be placed at 40.0' centers or as directed by the Engineer.

Posts shall be painted one shop coat of red lead, one first field or prime coat of red lead and one final coat of aluminum paint. All paint shall meet the requirements of section 71.06 of the Std. Specs.

The unit price bid for new steel guide posts shall include all labor, equipment & materials required to furnish & install Guide Posts complete in place, exclusive of reflectorization. If the contractor places posts by driving, suitable precautions shall be taken to prevent injury to the posts. If the posts are placed in holes, all backfill shall be thoroughly tamped.



PLAN OF GUIDE POSTS.

APPROVED Jan. 1 1956
Scott P. Hart
STATE HIGHWAY ENGINEER

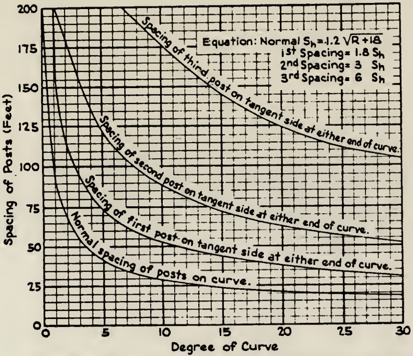
Montana State Highway Commission.

REV. 1-1-56

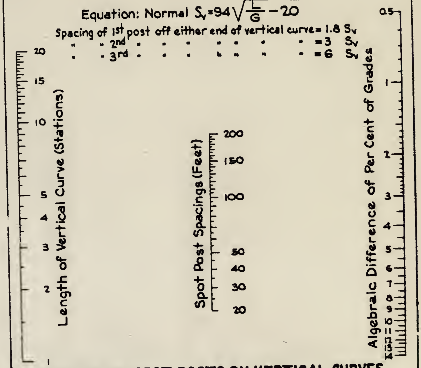
REV. 10-13-55

24 - GP3

SPACING OF SPOT POSTS



SPACING OF SPOT POSTS ON HORIZONTAL CURVES



SPACING OF SPOT POSTS ON VERTICAL CURVES

NOTES:

The spacing of Spot Posts on tangents beyond the limits of horizontal or vertical curves shall be 200 feet unless otherwise ordered by the Engineer.

Spot Posts shall be timber, Concrete or Steel as called for on the plans or in the Special Provisions.

Delineators are to be furnished & placed by State forces.

APPROVED Jan. 1 1936
STATE HIGHWAY ENGINEER

Montana State Highway Commission

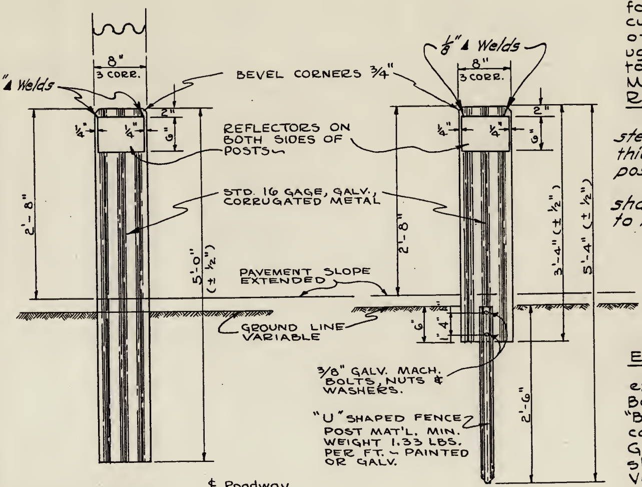
GP4

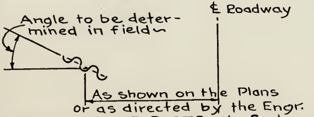
REV. 10-9-53

CORRUGATED METAL GUIDE POSTS

TYPE "A"
CORRUGATED METAL GUIDE POST

TYPE "B"
CORRUGATED METAL GUIDE POST




Angle to be determined in field
℄ Roadway
As shown on the Plans or as directed by the Engr.

PLAN OF GUIDE POSTS -No Scale-

If ground Adjacent to the Post is disturbed in any manner, it shall be backfilled to level of existing surface & compacted.

– GENERAL NOTES –

CORRUGATED METAL: If cut from Stock Sheets, Galvanizng shall be performed after cutting. Side cuts shall be on the Crown of Corrugations. The Corrugated Metal shall conform to AASHO – Designation – M-36 –

REFLECTORS:

Face plate shall be 6"×7½" steel plate of 16-ga. minimum thickness, securely welded to post as indicated.

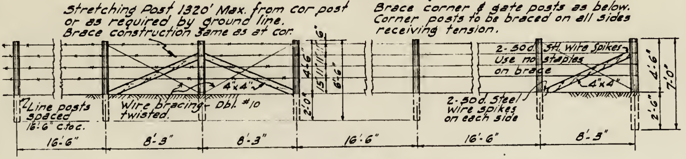
Reflectorizing material shall be furnished and applied to face plate by State Forces.

ERECTION: Care shall be exercised in tightening the Bolts used with the Type "B" posts so as not to cause warping of the Guide Post. The Posts shall be installed in a Vertical Plane and in such a manner as not to cause distortion. When in place, the Posts shall not vary more than 1" in 2' 8" from a Vert. plane

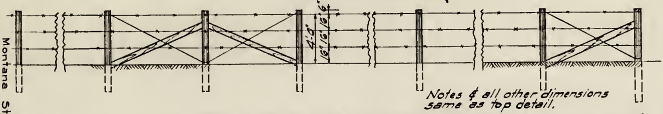
APPROVED Jan. 1 1956
Scott P. Hart
STATE HIGHWAY ENGINEER
REV. 1-1-56

26-GP5

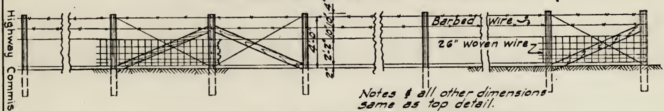
4 WIRE FENCE (TYPE F-4)


Stretching Post 1320' Max. from cor post or as required by ground line.
Brace construction same as at cor.
Brace corner & gate posts as below.
Corner posts to be braced on all sides receiving tension.
2-50d. St. wire spikes
Use no staples on brace
4"x4"
Line posts spaced 16'-6" c. to c.
Wire bracing- Dbl. #10 twisted.
2-50d. Steel wire spikes on each side
6"
15"
11"
11"
4'-6"
6'-6"
2'-0"
4'-6"
2'-6"
7'-0"
16'-6"
8'-3"
8'-3"
16'-6"
16'-6"
8'-3"

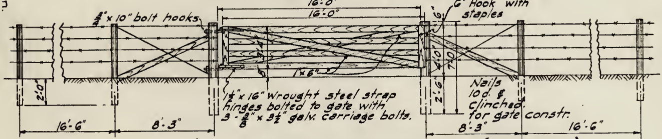
3 WIRE FENCE (TYPE F-3)



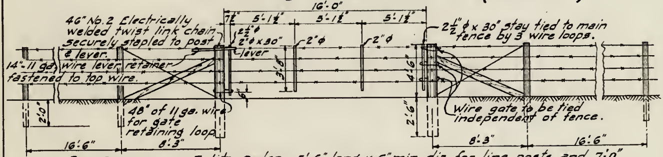
BARBED WIRE & WOVEN WIRE FENCE (TYPE F-2)



FARM ENTRANCE GATE (TYPE G-1)


16'-0"
16'-0"
3/4" x 10" bolt hooks
6" Hook with staples
6"
3'-4"
1"x6"
4'-0"
7'-0"
2'-0"
2'-6"
1 1/2" x 16" Wrought steel strap hinges bolted to gate with 3 - 3/8" x 3 1/2" galv. carriage bolts.
Nails 10d. & clinched for gate constr.
16'-6"
8'-3"
8'-3"
16'-6"

FIELD ENTRANCE GATE (TYPE G-2)


16'-0"
7 1/2"
5'-1 1/2"
5'-1 1/2"
5'-1 1/2"
46" No. 2 Electrically welded twist link chain securely stapled to post & lever.
2 1/2" ϕ
2" ϕ x 30" lever
2" ϕ
2" ϕ
2 1/2" ϕ x 30" stay tied to main fence by 3 wire loops.
14"-11 ga. wire lever retainer fastened to top wire.
3'-6"
4'-6"
6"
2'-0"
2'-6"
48" of 11 ga. wire for gate retaining loop
Wire gate to be tied independent of fence.
16'-6"
8'-3"
8'-3"
16'-6"

POSTS: — — — — — . Split cedar, 6'-6" long x 6" min. dia. for line posts and 7'-0" long x 8" min. dia. for corner & gate posts.

WIRE: – 2 point galv. barbed wire, approx. 350 lbs. per mile, 2 strands of 12 ga. wire twisted, with barbs spaced 5" apart. Woven wire 26" wide. Top & bottom wires #10 ga. Lines & stay wires #12 1/2 ga. Stays 12" apart. All wire to be attached to posts on pasture side of fence.

LUMBER: Full sawed Montana Larch, or Montana or Pacific Coast Douglas Fir. Braces may also be constructed of peeled round poles of a minimum diameter of 4 1/2"

STAPLES: 1 1/2" galvanized fence staples #9 wire.

ALTERNATE CONSTRUCTION.
Metal posts may be used in place of wood posts. Installation will be done according to manufacturers recommendations.
Leaning fence may be substituted if approved by the Engineer.

Montana State Highway Commission.

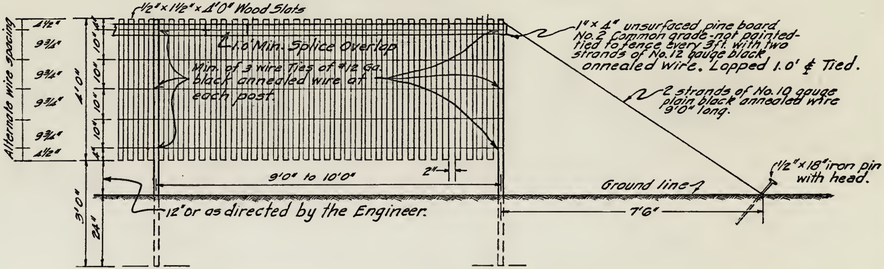
RIGHT OF WAY FENCE

APPROVED Jan. 1, 1956
Geo. P. Hart
STATE HIGHWAY ENGINEER

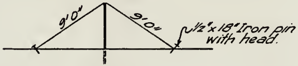
REV. 10-1-61

Montana State Highway Commission.

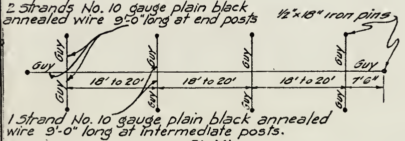
WOVEN WIRE WOOD SLAT SNOW FENCE


1/2" × 1 1/2" × 4'0" Wood Slats
Alternate wire spacing
4 1/2"
9 3/4"
9 3/4"
9 3/4"
9 3/4"
4 1/2"
4'0"
10"
10"
10"
10"
4"
4"
1.0' Min. Splice Overlap
Min. of 3 wire Ties of #12 Ga. black annealed wire at each post.
1" × 4" unsurfaced pine board No. 2 Common grade - not painted - tied to fence every 3 ft. with two strands of No. 12 gauge black annealed wire. Lapped 1.0' & Tied.
2 strands of No. 10 gauge plain black annealed wire 9'0" long.
9'0" to 10'0"
2"
1/2" × 18" iron pin with head.
Ground line
3'0"
24"
12" or as directed by the Engineer.
7'6"

METHOD OF GUYING



SECTION


2 Strands No. 10 gauge plain black annealed wire 9'-0" long at end posts
1/2" × 18" iron pins
GUY
GUY
GUY
GUY
GUY
GUY
GUY
GUY
GUY
GUY
18' to 20'
18' to 20'
18' to 20'
7'6"
1 Strand No. 10 gauge plain black annealed wire 9'-0" long at intermediate posts.

PLAN

Posts: to be 7'0" long and furnished without anchor. Posts shall be given at least one coat of approved paint. The section form of posts may be tubular, tee, equal angle, tee rail or modified channel provided that all posts weigh at least 1.33 pounds per lineal foot.

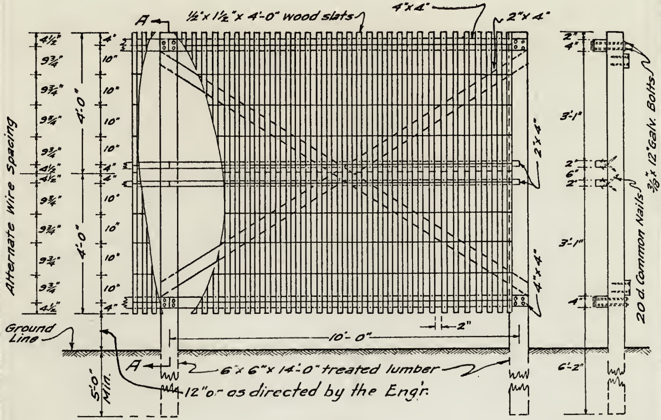
Wood Slats: 1/2" × 1 1/2" × 4'0" woven together with 5 cables, each consisting of 2 galvanized wires - not smaller than No. 12 1/2 (A S & W gauge). Slats to be placed 2" apart. Each cable to have 2 complete turns in the weave in each space between slats. All slats to be immersed in hot solution of creosote or red oxide of iron.

APPROVED Jan. 1, 1936
STATE HIGHWAY ENGINEER

REV. 10-1-51

WOVEN WIRE WOOD SLAT SNOW FENCE (DOUBLE HEIGHT)

NOTE:- 2"x4" & 4"x4" bracing cut to fit field staking.



ELEVATION
Scale 3/8" = 1'-0"

SECTION A-A

WOOD SLATS: See Standard Specifications for Wood Slat Snow Fence.

LUMBER: All lumber shall be untreated except 6"x6"x14'-0" posts which shall be treated as called for in the Standard Specifications. All holes shall be bored before treatment. Lumber shall be Pacific Coast Douglas fir or an approved equal and shall be equal to the grade defined as select common in accordance with American Lumber Standards for soft wood lumber.

BOLTS: 4"x4" Stringers to be bolted to 6"x6" Posts with 3/8" Galvanized Bolts using 1½" Diam. Galvanized Washers between all bolt heads and nuts and the wood.

STAPLES: Wood slat snow fence to be stapled to stringers with 1" Galvanized Staples using 21 Staples per row per 10'-0" section.

BRACES: 2"x4" braces to be used at each end section, and at 100' intervals where length of fence permits.

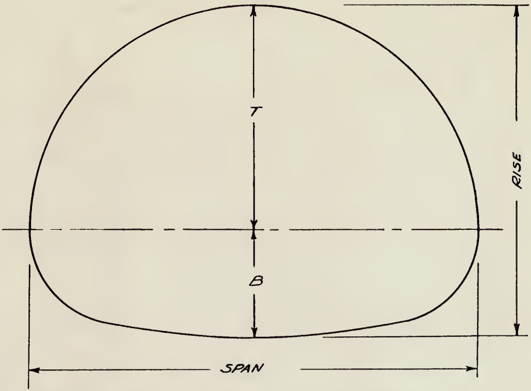
NAILS: 2"x4" stringers and braces to be nailed or toe-nailed to 6"x6" posts with 20d. common nails.

TAMPING: Backfill around posts shall be thoroughly tamped and compacted. Watering shall be resorted to for thorough compaction if required by the Engineer.

APPROVED Jan. 1, 1956
Scott P. Hart
STATE HIGHWAY ENGINEER

MONTANA STATE HIGHWAY COMMISSION

DIMENSIONS OF C.M. PIPE ARCH CULVERTS



NOTE:- A tolerance of plus or minus 1-inch will be permissible in span, rise & "B".

NOTE: ALL DIMENSIONS ARE MEASURED FROM INSIDE CRESTS.

Span	Rise	Area	B	Height Of Cover In Feet						DIA. OF EQUIV. ROUND PIPE IN INCHES
In.	In.	Sq ft.	In.	1	2-4	5-9	10-15	16-20		
18	11	1.1	4½	16	16	16	16	16	MIN. REQUIRED GAGE	15
22	13	1.6	4¾	16	16	16	16	16		18
25	16	2.2	5	16	16	16	16	16		21
29	18	2.8	5½	14	14	14	14	14		24
36	22	4.4	6¼	14	14	14	14	14		30
43	27	6.4	7	12	12	12	12	12		36
50	31	8.7	8	12	12	12	12	10		42
58	36	11.4	9¼	10	12	12	10	10		48
65	40	14.3	10½	8	10	10	8	8		54
72	44	17.6	11¾	7	8	8	7	---		60

MULTIPLE INSTALLATIONS

Where multiple lines of pipe are installed, the adjacent sides shall be one-half the largest horizontal diameter apart with 4 ft. the maximum.

APPROVED Jan. 1, 1956
Scott P. Hart
STATE HIGHWAY ENGINEER

MONTANA STATE HIGHWAY COMMISSION

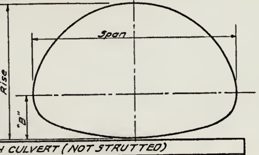
REV. 10-1-51
REV. 8-7-53
REV. 1-1-56

DIMENSIONS OF STRUCTURAL PLATE PIPE & STRUCTURAL PLATE PIPE ARCH CULVERTS

STRUCTURAL PLATE PIPE CULVERT (STRUTTED & NOT STRUTTED)

Diameter of pipe in inches.*	60	72	84	96	108	120	132	144	156	168	180	
Area in square feet	20	28	38	50	64	79	95	113	133	154	177	
Height of cover in feet												
1 - 5, Incl.	10	10	10	10	10	8	8	8	8	7	5	
6 - 10, Incl.	10	10	10	10	10	10	10	8	8	8	8	
11 - 15, Incl.	10	10	10	10	10	10	10	10	10	10	8	
16 - 20, Incl.	10	10	10	10	10	10	10	10	8	8	8	
21 - 25, Incl.	10	10	10	10	10	10	10	8	8	8	8	
26 - 30, Incl.	10	10	10	10	10	10	8	8	8	7	5	
31 - 35, Incl.	10	10	10	10	10	8	8	7	5	5	3	
36 - 40, Incl.	10	10	10	10	8	7	7	5	3	3	1	
41 - 45, Incl.	10	10	10	8	7	5	5	3	1	1	–	
46 - 50, Incl.	10	10	8	7	5	5	3	1	1	–	–	
51 - 55, Incl.	10	8	8	7	5	3	1	1	–	–	–	
56 - 60, Incl.	10	8	7	5	3	1	1	–	–	–	–	
61 - 70, Incl.	8	7	5	3	1	–	–	–	–	–	–	
71 - 80, Incl.	7	5	3	1	–	–	–	–	–	–	–	
81 - 90, Incl.	5	3	1	–	–	–	–	–	–	–	–	
91 - 100, Incl.	5	1	–	–	–	–	–	–	–	–	–	

*- Stock diameters are available in 6" increments from 60" to 180". For sizes of pipe which are between those in the tables, the gage shall be interpolated where possible; otherwise the gage of the next larger size shall be used.



All structural plate pipe culverts shall be factory formed 5% elliptically.

Unless otherwise noted on the plans, end plates shall be beveled on a 1½:1 slope, and circular pipes shall be beveled above the flow line, and arch pipes shall be beveled above the largest horizontal diameter. When ends are beveled, the angle of skew shall not exceed 15° unless otherwise noted. See Std. 102-GCRR for multiple pipe installation.

STRUCTURAL PLATE PIPE ARCH CULVERT (NOT STRUTTED)

Span	Rise	Area Sq. Ft.	"B"* Inches	Height of Cover in Feet														
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
6'-1"	4'-7"	22	21.0	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
6'-4"	4'-9"	24	20.5	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
6'-9"	4'-11"	26	22.0	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
7'-0"	5'-1"	28	21.4	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
7'-3"	5'-3"	31	20.8	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
7'-8"	5'-5"	33	22.4	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
7'-11"	5'-7"	35	21.7	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
8'-2"	5'-9"	38	20.9	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
8'-7"	5'-11"	40	22.7	10	10	10	10	10	10	10	10	10	10	10	10	10	10	8
8'-10"	6'-1"	43	21.9	10	10	10	10	10	10	10	10	10	10	10	10	10	8	8
9'-4"	6'-3"	46	23.8	8	10	10	10	10	10	10	10	10	10	10	10	8	8	8
9'-6"	6'-5"	49	22.9	8	8	10	10	10	10	10	10	10	10	10	8	8	8	8
9'-9"	6'-7"	52	21.9	8	8	10	10	10	10	10	10	10	10	10	8	8	8	7
10'-3"	6'-9"	55	24.0	8	8	10	10	10	10	10	10	10	10	8	8	8	7	7
10'-8"	6'-11"	58	26.1	8	8	8	10	10	10	10	10	10	10	8	8	8	7	7
10'-11"	7'-1"	61	25.1	8	8	8	10	10	10	10	10	10	8	8	8	7	7	5
11'-5"	7'-3"	64	27.4	7	8	8	8	10	10	10	10	8	8	8	8	7	5	5
11'-7"	7'-5"	67	26.3	7	8	8	8	8	10	10	8	8	8	8	7	5	5	5
11'-10"	7'-7"	71	25.2	7	8	8	8	8	8	8	8	8	8	8	7	5	5	3
12'-4"	7'-9"	74	27.5	7	7	8	8	8	8	8	8	8	8	7	7	5	5	3
12'-6"	7'-11"	78	26.4	7	7	8	8	8	8	8	8	8	8	7	7	5	5	3
12'-8"	8'-1"	81	25.2	5	7	8	8	8	8	8	8	8	8	7	7	5	5	3
12'-10"	8'-4"	85	24.0	5	7	8	8	8	8	8	8	8	7	7	5	5	3	1
13'-5"	8'-5"	89	26.4	5	5	7	7	8	8	8	8	7	7	5	5	3	3	1
13'-11"	8'-7"	93	28.9	5	5	7	7	8	8	8	7	7	5	5	3	3	1	1
14'-1"	8'-9"	97	27.6	5	5	7	7	8	8	8	7	7	5	5	3	3	1	1
14'-3"	8'-11"	101	26.3	3	5	5	7	7	7	7	7	7	5	5	3	3	1	1
14'-10"	9'-1"	105	28.9	3	5	5	7	7	7	7	7	5	3	3	1	1	–	–
15'-4"	9'-3"	109	31.6	3	5	5	7	7	7	7	7	5	3	3	1	–	–	–
15'-6"	9'-5"	113	30.2	1	3	5	5	7	7	7	5	3	3	1	1	–	–	–
15'-8"	9'-7"	118	28.8	1	3	5	5	7	7	7	5	3	3	1	1	–	–	–
15'-10"	9'-10"	122	27.5	1	3	5	5	7	7	7	5	3	3	1	1	–	–	–
16'-5"	9'-11"	126	30.1	–	1	3	3	5	5	5	3	3	1	1	–	–	–	–
16'-7"	10'-1"	131	28.7	–	1	3	3	5	5	5	3	1	1	1	–	–	–	–

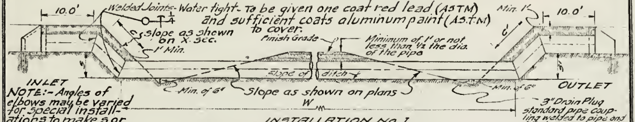
*- For design purposes only.

Montana State Highway Commission

APPROVED Jan. 1, 1956
Scott P. Hart
STATE HIGHWAY ENGINEER

REV. 3-19-56 1-1-56

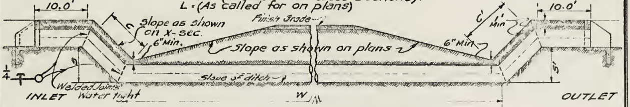
CORRUGATED METAL PIPE SYPHON


10.0'
Welded Joints- Water tight- To be given one coat red lead (ASTM) and sufficient coats aluminum paint (A.S.T.M) to cover.
1/4
Slope as shown on X-sec.
C
1' Min.
S
Finish Grade
Minimum of 1' or not less than 1/2 the dia. of the pipe
Slope of ditch
Min. 1'
C'
10.0'
S'
INLET
Min. of 6"
Slope as shown on plans
Min. of 6"
OUTLET
W
3" Drain Plug standard pipe coupling welded to pipe and filled with standard pipe plug secured to barrel of pipe with swivel & chain

NOTE:- Angles of elbows may be varied for special installations to make s or s' fit the situation.

INSTALLATION No. 1

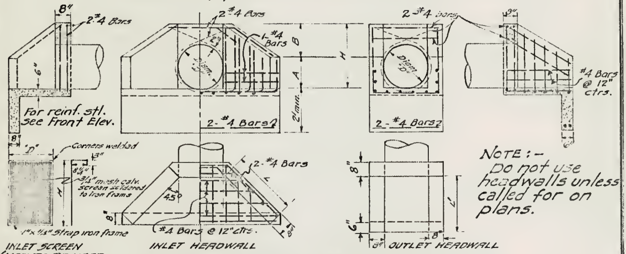
Length of Syphon Pipe = W+C+C'+20'
W = (Scaled from cross sections).
L = (As called for on plans)



INSTALLATION No. 2

To be used where Installation No. 1 is not possible due to less than minimum S-S' or less than minimum cover.

Payment for pipe to be made for length measured along ℄ of pipe



NOTE :-
Do not use headwalls unless called for on plans.

All exposed corners of concrete to be chamfered 1"
Reinforcing steel to be not less than 1 1/2" to nearest face of concrete
Screen to be included in the Unit Price bid for Lin. Ft. of pipe.

INLET ℄ OUTLET HEADWALLS FOR C.M.P.

* SYPHON PIPE			CL. "AD" CONC. CU. YDS.		REINF. STL. LBS.		DIMENSION TABLE					
DIA. "D"	AREA SQ. FT.	MIN. C or C'	INLET	OUTLET	INLET	OUTLET	L	L'	A	B	H	⊕ GAGE
18"	1.77	2.0	.73	.59	62	50	2'-6"	2'-2"	1'-3"	1'-3"	2'-6"	16
24"	3.14	2.0	.91	.76	82	54	3'-0"	2'-6"	1'-6"	1'-6"	3'-0"	14
30"	4.91	2.0	1.06	.95	99	66	3'-6"	2'-10"	1'-9"	1'-9"	3'-6"	14
36"	7.07	2.0	1.68	1.11	116	82	4'-0"	3'-2"	2'-0"	2'-0"	4'-0"	12
42"	9.62	2.0	2.10	1.40	139	105	4'-6"	3'-6"	2'-3"	2'-3"	4'-6"	12
48"	12.57	2.0	2.32	1.66	162	124	5'-0"	3'-10"	2'-6"	2'-6"	5'-0"	10

⊕ For fills under 10.0'
* Syphon pipe to be corrugated metal, close riveted and soldered water-tight
Reinforcement steel as indicated to be included in the unit price bid per cu. yd. of conc.
Maximum S or S' = 10'.
Or Reinf. Conc. Syphon pipe as called for in the Standard Specifications.
See Std. 93-53 For RCP Headwalls.

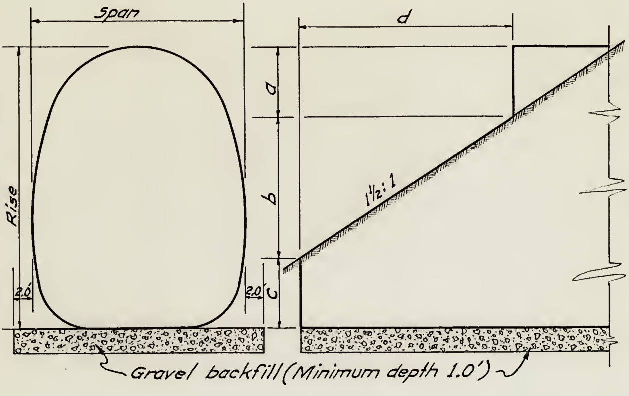
NOTE:- Field connections will not be allowed within 15 feet of the centerline of the road.

Montana State Highway Commission

APPROVED Jan. 1, 1956
Scott P. Hart
STATE HIGHWAY ENGINEER

REV. 10-23-56 REV. 10-1-51
REV. 8-7-53
REV. 1-1-56

STRUCTURAL PLATE PIPE STOCKPASS



DIMENSIONS

Design	Rise	Span	Gage	a *	b *	c *	d *
A	6'-6"	5'-10"	10	1'-4"	3'-10"	1'-4"	5'-9"
B	7'-7"	5'-10"	10	1'-8"	4'-7"	1'-4"	6'-10"

*- For design purposes only. Beveling shall commence at the bottom of the top plate and extend downward on a 1½ : 1 slope to the top of the corner plate.

A tolerance of ± 4% in span & rise will be acceptable.

The length shall be measured along the flow line of the stockpass.

Unless otherwise called for, end plates shall be beveled as shown above, and shall be measured and paid for at the unit price bid per lineal foot of structural plate pipe stockpass. When ends are beveled, the angle of skew shall not exceed 15° unless otherwise noted.

See Std. 54-GCRR for riprap if toe protection is necessary.

Minimum cover = 2.0 ft. to finish grade.

Maximum cover = 6.0 ft. to finish grade.

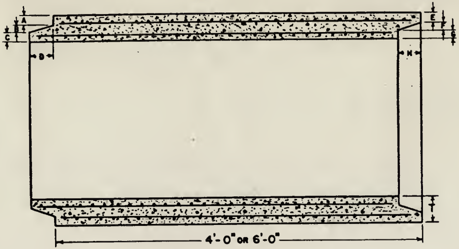
Fill slopes shall be warped min. 25.0' on each side of stockpass to fit 1½ : 1 bevel.

APPROVED Jan. 1, 1956
Scott P. Hart
STATE HIGHWAY ENGINEER

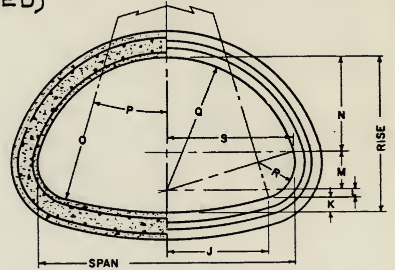
Montana State Highway Commission

1-1-56

REINFORCED CONCRETE PIPE ARCH CULVERTS
(PREFABRICATED)



LONGITUDINAL SECTION



TRANSVERSE SECTION & END VIEW

SIZE	WATER AREA SQ. FT.	RISE	SPAN	As*	T	A	B	C	D	E	F	G	H	J	K	L	M	N	O	P	Q	R	S
24"	2.8	18"	28 1/2"	0.25	3 1/2"	1 5/8"	1/2"	1 3/8"	3"	1 3/8"	1/2"	1 5/8"	3"	10 7/8"	1 7/16"	1 13/16"	2 11/16"	10 13/16	40 11/16	15° 30'	14 3/4"	4 5/8"	14 7/32"
30"	4.4	22 1/2"	36 1/4"	0.22	4"	1 13/16"	5/8"	1 9/16"	3 1/2"	1 9/16"	5/8"	1 13/16	3 1/2"	13 5/8"	1 13/16"	2"	5 13/16"	12 7/8	51"	15° 30'	18 3/4"	6 1/8"	17 3/4"
36"	6.4	26 5/8	43 3/4	0.25	4 1/2"	2"	3/4"	1 3/4"	4"	1 3/4"	3/4"	2"	4"	17 1/8"	2 3/8"	1 3/4"	6 1/4"	16 1/4	62"	16° 00'	22 1/2	6 1/2	21 5/8
42"	8.8	31 5/16	51 1/8	0.30	4 1/2"	2"	3/4"	1 3/4"	4"	1 3/4"	3/4"	2"	4"	20"	2 3/4"	2 5/16"	7 3/16"	19 1/16	73"	15° 15'	26 1/4	7 3/4	25 1/4
48"	11.4	36"	58 1/2	0.33	5"	2 1/4"	3/4"	2"	5"	2"	3/4"	2 1/4"	5"	22 3/4	3 1/8"	2 7/8"	8 1/8"	21 7/8"	84"	15° 40'	30	8 7/8	28 7/8
60"	17.7	45"	73 1/2"	0.40	6"	3 5/16"	3/4"	1 15/16"	5"	2 3/4"	3/4"	2 1/2"	5"	28 1/2"	3 15/16"	3 9/16"	10 3/16"	27 9/16"	105"	15° 45'	37 1/2"	11 1/16"	36 1/8"
72"	25.6	54"	88"	0.59	7"	3 13/16"	1"	2 3/16"	6"	3 1/4"	1"	2 3/4"	6"	34 3/16	4 3/4"	4 1/4"	12 1/4"	32 3/4"	126"	15° 45'	45"	13 5/16"	43 5/16"

NOTE: For R.C. Flared End Sections
See Std. Sheet No. 77 - C73

*As = MINIMUM REINFORCEMENT FOR EACH
OF THE TWO LINES - STEEL AREA IN
SQUARE INCHES PER LINEAL FOOT
OF PIPE BARREL

CONCRETE - 3500 P.S.I.

Montana State Highway Commission

APPROVED Jan. 1, 1956
Scott P. Hart
STATE HIGHWAY ENGINEER

52-RC

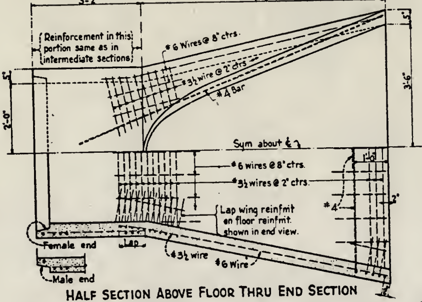
REV. 10-5-53
REV. 8-22-55

STANDARD SECTIONAL REINF. CONC. UNDERPASS

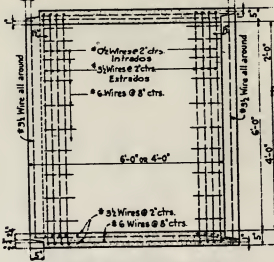
Construction methods, reinforcing steel, concrete, methods of measurement & basis of payment shall conform to the specifications for Reinforced Concrete Pipe Culverts....

Montana State Highway Commission

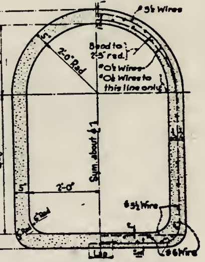
HALF PLAN OF END SECTION - SHOWING WING WALL REINFMT.



HALF SECTION ABOVE FLOOR THRU END SECTION



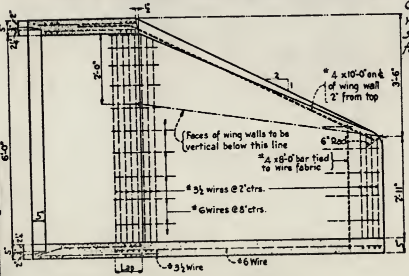
LONGITUDINAL SECTION ON ¢



TRANSVERSE SECTION

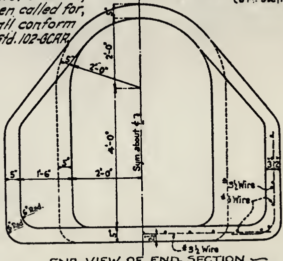
DETAILS OF INTERMEDIATE SECTIONS

EST. WEIGHT { 4 FT. SECTION 4950 LBS.
6 FT. SECTION 7420 LBS.


5"
2½"
2'-0"
6'-0"
3'-6"
#4 x10'-0" on ¢ of wing wall 2" from top
2
1
Faces of wing walls to be vertical below this line
6" Rad.
#4 x8'-0" bar tied to wire fabric
2'-11"
#3½ wires @ 2" ctrs.
#6 wires @ 8" ctrs.
5"
Lap
#3½ Wire
#6 Wire

LONGITUDINAL SECTION ON ¢ OF END SECTION
CONCRETE - 4500 LBS. PER SQ. IN.
STL. FABRIC - AASHO SPEC'S: M-55

Gravel backfill, when called for, shall conform to Std. 102-GCRR.



END VIEW OF END SECTION ~
EST. WEIGHT OF END SECT. 10,650 LBS.

MEASURED ALONG F.L., WHEN END SECTIONS ARE CALLED FOR, THEY ARE TO BE MEASURED AND PAID FOR AT THE UNIT PRICE BID FOR STANDARD SECTIONAL REINFORCED CONCRETE UNDERPASS ~

Construction Notes:-

If the splices are not electrically welded, the reinforcement shall be lapped not less than 40 diameters.

If the splices are electrically welded, the members at either a welded splice or intersection shall develop a tensile strength across the weld not less than the minimum required strength of the fabric.

Four foot lengths shall be used only to secure required length of culvert. Short lengths of pipe shall be installed near ends of culvert.

Not more than two 4 ft. sections shall be used in any culvert.

Cover over top of U-Pass min. 2'-0". max. 10'-0".

APPROVED Jan. 1, 1936
STATE HIGHWAY ENGINEER

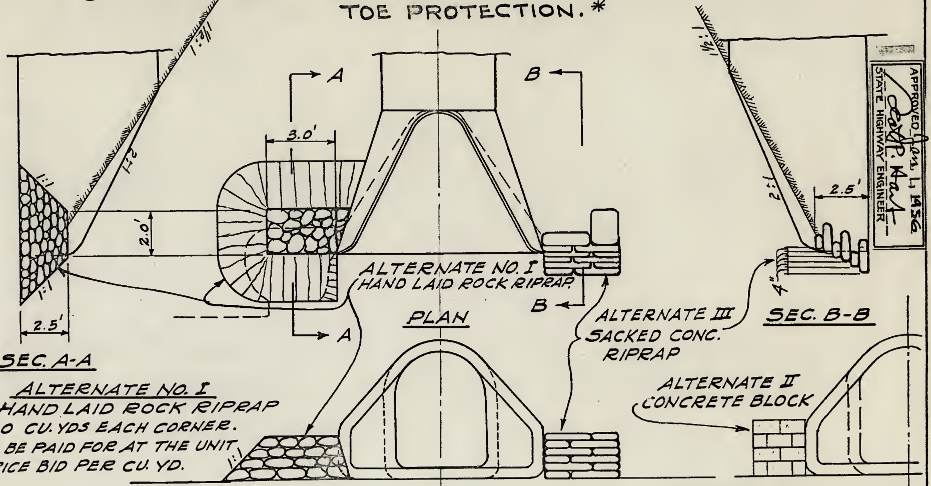
REV. 10-1-51
REV. 1-1-56

53
RC

STANDARD SECTIONAL REINFORCED CONCRETE UNDERPASS TOE PROTECTION. *

Montana State Highway Commission.

APPROVED Jan 1, 1956
[signature]
STATE HIGHWAY ENGINEER



ALTERNATE NO. I

HAND LAID ROCK RIPRAP

2.0 CU. YDS EACH CORNER.
TO BE PAID FOR AT THE UNIT PRICE BID PER CU. YD.

* This standard applies also to Std's. 44-SPPS & 55-RCSP.

ALTERNATE II - CONCRETE BLOCK

TO BE MADE OF 10, 8"X 8"X 16" CONCRETE BLOCKS, MEETING A.S.T.M. SPECIFICATION C 90-44 GRADE B, AT EACH CORNER, LAID WITH A 1.0' BATTER. MORTAR SHALL CONSIST OF 1 PART HYDRATED LIME, 6 PARTS OF SAND & 1 PART CEMENT. TO BE INCLUDED IN THE UNIT PRICE BID FOR CONC. U-PASS.

ALTERNATE III.

SACKED CONC. RIPRAP

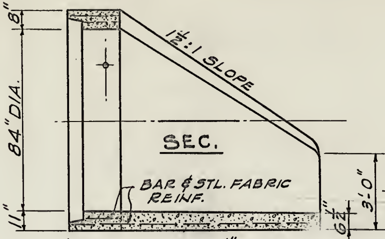
MIN. 12 SACKS EACH CORNER

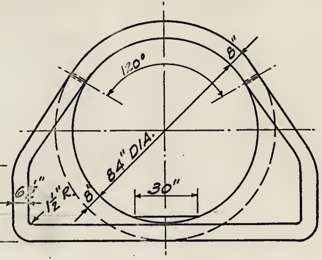
CONCRETE IN SACKS TO BE SAME PROPORTION OF AGGREGATES AND CEMENT AS USED IN CONC. PIPE. TO BE INCLUDED IN THE UNIT PRICE BID FOR CONC. U-PASS.

REV. 1-1-56

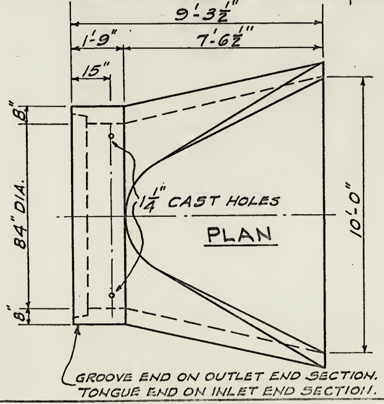
RCRR 54

84" REINF. CONC. FLAT BOTTOM STOCK PASS.





END VIEW


9'-$3\frac{1}{2}$"
1'-9"
7'-$6\frac{1}{2}$"
15"
8"
84" DIA.
8"
$1\frac{1}{4}$" CAST HOLES
10'-0"
GROOVE END ON OUTLET END SECTION.
TONGUE END ON INLET END SECTION.

PLAN

NOTE:- REINF. STEEL & CONCRETE SHALL CONFORM TO SPECIFICATIONS FOR REINF. CONC. PIPE.
FLARED END TERMINAL SECTIONS TO BE INCLUDED IN LENGTH OF PIPE AS SHOWN ON PLANS.

SEE STD. 54-RCRR FOR TOE PROTECTION IF NECESSARY.

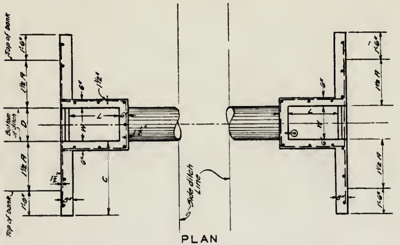
Montana State Highway Commission

APPROVED Jan. 1 1956
STATE HIGHWAY ENGINEER

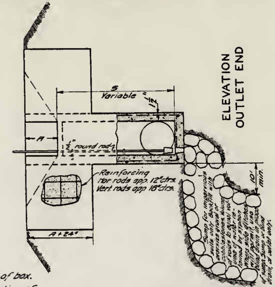
3-23-55
REV. 1-1-56

55
RCSP

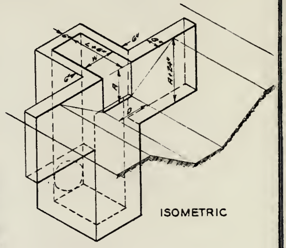
REINFORCED CONCRETE SYPHON



PLAN


S Variable
1½"
A
¾" round rod
Reinforcing Hor. rods app. 12" ctrs. Vert. rods app. 18" ctrs.
10' min.
A+24"
Sump for impervious soils only. Backfill with oversize gravel or cobblestones. Volume of voids to equal vol. of water retained by syphon. Where side ditches will permit, use blind drain in place of sump. Sump or blind drain at outlet only.

ELEVATION
OUTLET END



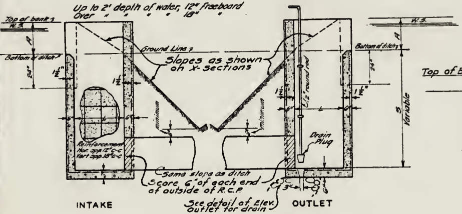
ISOMETRIC

NOTES: "W" minimum = 24"; above 24" "W" = outside diameter of pipe or inside width of box.
"L" = 36" minimum to increase as necessary to make areas of cross section of box and well equal.
When "S" exceeds 4', inside face of well to be reinforced the same as outside face. In no case shall "S" exceed 6'. Reinforce with #5 steel as shown.
Concrete = Class "AD"
All exposed corners of concrete to be chamfered 1".

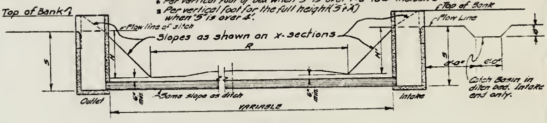
INTAKE + OUTLET

⊙ SIZE OF PIPE	DIMENSIONS						QUANTITIES (INTAKE + OUTLET)						AREA PIPE SQ. FT.	⊗ GAGE
							CU. YDS. CLASS "AD" CONC.		LBS STEEL	PER VERT. FT. OF BOX				
										CU. YDS CONC.		LBS. STEEL		
	S	L	W C.M.P.	W R.C.P.	A	C	C.M.P.	R.C.P.		C.M.P. *	R.C.P. *	* ▪		
18"	1'-6"	3'-0"	2'-0"	2'-0"	1'-11"	4'-4½"	3.25	3.25	276	0.44	0.44	39 – 71	1.77	16
24"	1'-6"	3'-0"	2'-0"	2'-6"	2'-7"	5'-4½"	4.16	4.28	325	0.44	0.48	39 – 71	3.14	14
30"	1'-6"	3'-0"	2'-0"	3'-1"	3'-0"	6'-0"	4.94	5.06	394	0.48	0.52	44 – 78	4.91	14
36"	1'-6"	3'-0"	2'-0"	3'-8"	3'-5"	6'-7½"	5.77	5.90	471	0.52	0.57	46 – 82	7.07	12

⊙ For fills under 10.0'
⊗ Corrugated metal close riveted and soldered water tight (Syphon Pipe)
Reinf. conc. Syphon pipe as called for in the Standard Specifications.
* Per vertical foot of box when "S" is over 1'-6" to 4' inclusive
▪ Per vertical foot for the full height (S+A) when "S" is over 4'.


Up to 2' depth of water, 12" freeboard
Over " " " " 18" "
Top of bank
W.S.
A
Bottom of ditch
24"
1½"
1½"
Ground Line
Slopes as shown on X-sections
minimum
minimum
6"
Reinforcement Hor. app. 12" c-c Vert. app. 18" c-c
Same slope as ditch
Score 6" of each end of outside of R.C.P.
See detail of Elev. Outlet for drain
W.S.
A
Bottom of ditch
24"
1½"
1½"
¾" round rod
L
6"
6"
Drain Plug
S Variable
3"
6"
INTAKE
OUTLET

LONGITUDINAL SECTION



VERTICAL SECTION ON ℄ OF SYPHON
MINIMUM LENGTH OF PIPE NEEDED=R+H+H'

Berm may be left between Syphon well and top of cut slope.

Montana State Highway Commission

APPROVED Jan. 1 1936
Scott P. Hart
STATE HIGHWAY ENGINEER

M86

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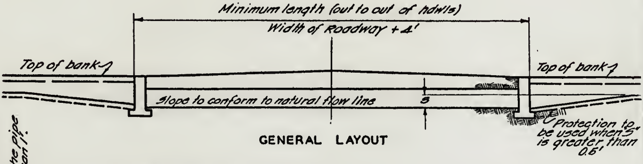
REV. 10-1-51
REV. 8-7-53

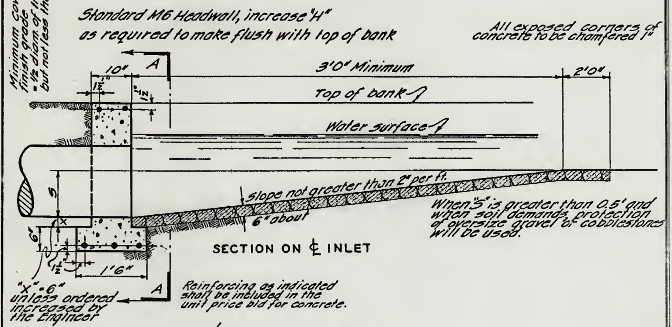
CONVERTED CULVERT SYPHON

(Use when "S" is 12" or less)


Minimum length (out to out of hdwls)
Width of Roadway + 4'
Top of bank
Top of bank
Slope to conform to natural flow line
S

Protection to be used when "S" is greater than 0.5'

GENERAL LAYOUT



Minimum cover to finish grade = ½ diam. of the pipe but not less than 1'.

Standard M6 Headwall, increase "H" as required to make flush with top of bank

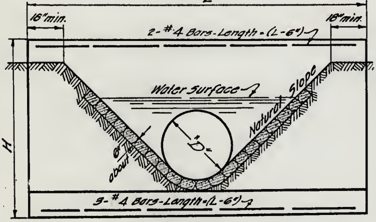
All exposed corners of concrete to be chamfered 1"

When "S" is greater than 0.5' and when soil demands protection of oversize gravel or cobblestones will be used.

SECTION ON ℄ INLET

"X" = 6" unless ordered increased by the Engineer

Reinforcing as indicated shall be included in the unit price bid for concrete.



SECTION A-A

Where "S" is greater than 0.5' or when soil demands, protection of oversize gravel or cobblestones will be used. Should the natural slope of ditch banks be such that the protection will not stand, use cement grout.

⊗ For fills under 10.0'

Diam. * of Pipe	"L"	Class "AD" Concrete		GAGE ⊗
		Conc. in 2 M6 Hdwls. X = 6"	Conc. 2-Hdwls. for ¼ ft. Additional H	
18"	6'0"	1.34	0.092	16
24"	8'0"	1.98	0.123	14
30"	10'0"	2.72	0.154	14
36"	12'0"	3.56	0.185	12

* Syphon pipe to be corrugated metal, close riveted and soldered water-tight.
Or Reinf. Conc. syphon pipe as called for in the Standard Specifications.

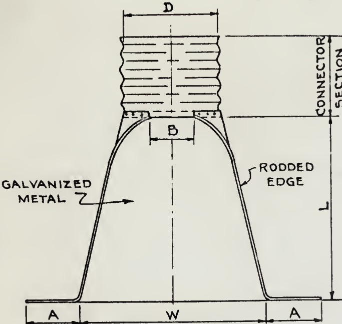
APPROVED Jan. 1, 1956
Scott P. Hart
STATE HIGHWAY ENGINEER

Montana State Highway Commission

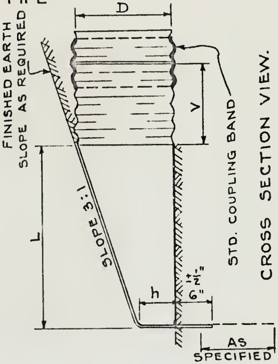
REV. 10-1-51
REV. 8-7-53

FLARED END TERMINAL SECTION (PREFABRICATED) FOR CORRUGATED METAL PIPE

* STYLE "A"

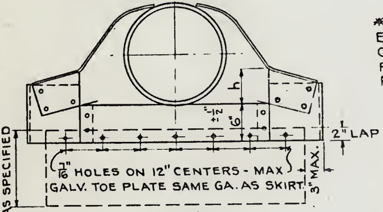


PLAN VIEW



CROSS SECTION VIEW.

*- STYLE "A" AND STYLE "B"
EITHER STYLE ACCEPTABLE DEPENDING ON MANUFACTURER SPECIFICATIONS.
F.E.T.S. TO BE INCLUDED IN LENGTH OF PIPE AS SHOWN ON PLANS.


h
±1/2"
6"
2" LAP
7/16" HOLES ON 12" CENTERS - MAX
GALV. TOE PLATE SAME GA. AS SKIRT.
3" MAX.
AS SPECIFIED

ELEVATION.

TOE PLATE TO BE PUNCHED WITH 7/16" HOLES TO MATCH HOLES IN SKIRT LIP. 3/8" GALV. BOLTS TO BE FURNISHED. LENGTH OF TOE PLATE EXT. SHOWN ON PLANS. AVAILABLE STANDARD DEPTHS - 12", 15", 18", 24", 30", 36" & 48".

TOE PLATE EXTENSIONS TO BE USED ONLY WHEN SPECIFIED.

SKIRT SECTION MAY BE MADE FROM TWO SHEETS JOINED ON ℄ BY RIVETING, BOLTING OR WELDING. IF WELDED, JOINT IS TO BE GIVEN ONE COAT OF RED LEAD (ASTM) AND SUFFICIENT COATS ALUMINUM PAINT (ASTM) TO COVER.

CONNECTOR SECTION, SKIRT, CORNER PLATES AND TOE PLATE TO BE GALV. AND SAME GAGE AS PIPE.

DELETE RODDED END ON ALL PIPE USING FLARED END SECTIONS.

FOR DETAIL OF ALTERNATE CONNECTIONS SEE STD. DWG. NO. 72-FS

CULV DIA.	GAGE	DIMENSIONS						
		"A" (MIN.)	"B" (MAX.)	"L" (2" TOL)	"W" (2" TOL.)	"h" (1/2" TOL.)	"V" 2"TOL	"S" 2"TOL.
12"	16	9"	6"	24"	24"	4"	12"	36"
15"	16	9"	7½"	30"	30"	5"	6"	36"
18"	16	9"	9"	36"	36"	6"	12"	48"
24"	14	9"	12"	46"	48"	8"	12"	58"
30"	14	9"	15"	60"	59"	10"	12"	72"
36"	12	14"	18"	72"	70"	12"	12"	84"
42"	12	14"	21"	84"	82"	14"	12"	96"
48"	12	14"	24"	96"	94"	16"	12"	108"

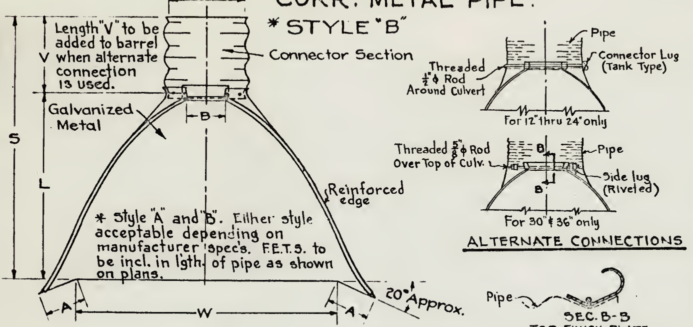
APPROVED Jan. 1, 1956
Scott P. Hart
STATE HIGHWAY ENGINEER

Montana State Highway Commission.

REV. 10-23-56
REV. 3-11-55
REV. 1-1-56
REV. 12-3-49
REV. 10-1-51

FLARED END TERMINAL SECTION (PREFABRICATED) FOR CORR. METAL PIPE. FS

* STYLE "B"

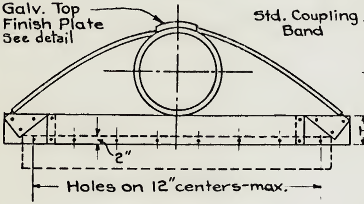

Diam.
Length "V" to be added to barrel when alternate connection is used.
V
S
L
Connector Section
Galvanized Metal
B
Reinforced edge
A
W
A
20° Approx.
Pipe
Connector Lug (Tank Type)
Threaded ½"ϕ Rod Around Culvert
For 12" thru 24" only
Threaded ⅝"ϕ Rod Over Top of Culv.
B
B
Pipe
Side lug (Riveted)
For 30" & 36" only
Pipe

* Style "A" and "B". Either style acceptable depending on manufacturer spec's. F.E.T.S. to be incl. in lgth. of pipe as shown on plans.

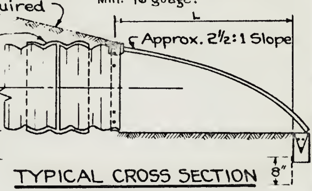
PLAN

ALTERNATE CONNECTIONS

SEC. B-B
TOP FINISH PLATE
Two guages less than apron. Min. 16 guage.



ELEVATION



TYPICAL CROSS SECTION

PIPE DIAM.	GA.	DIMENSIONS						
		A 1" TOL.	B MAX.	H 1" TOL.	L 1½" TOL.	W 2" TOL.	V 2" TOL.	S 2" TOL.
12"	16	4¾"	6"	6"	21"	24"	15"	36"
15"	16	6"	8"	6"	26"	30"	10"	36"
18"	16	7"	9"	6"	31"	36"	17"	48"
24"	14	9½"	12"	6"	42"	48"	16"	58"
30"	14	12"	15"	7½"	52½"	60"	19½"	72"
36"	12	14"	18"	9"	63"	72"	21"	84"
42"	12	16"	21"	10½"	73½"	84"	22½"	96"
48"	12	18"	27"	12"	84"	90"	24"	108"

Toe Plate, where needed, to be punched to match holes in skirt lip. ⅜" galv. bolts to be furnished. Length of toe plate is W+10" for 12" to 30" dia. pipe incl. and W+22" for 36" to 48" dia. pipe incl.

Skirt section may be made from two sheets joined on ℄ by riveting, bolting or welding. If welded, joint is to be given one coat of red lead (ASTM) and sufficient coats aluminum paint (ASTM) to cover.

Connector Section, Corner Plate and Toe Plate to be same gage as skirt and each to be galvanized.

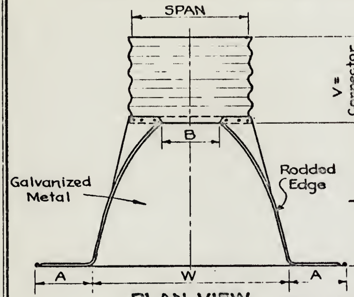
Delete rodded ends on all pipe using Flared End Sections.

APPROVED Jan. 1, 1956
Scott P. Hart
STATE HIGHWAY ENGINEER

Montana State Highway Commission

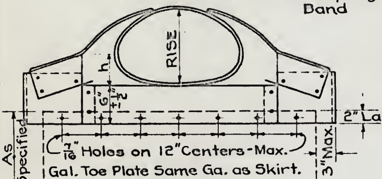
REV 3-11-55
REV. 10-23-56
REV. 3-8-55
3-28-52

FLARED END TERMINAL SECTION(PREFABRICATED) FOR CORRUGATED METAL PIPE-ARCH CULVERT

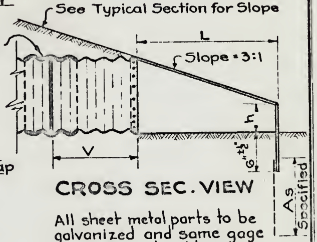


PLAN VIEW

For Detail of Alternate CONNECTIONS SEE STD. DWG. NO. 72-FS


RISE
h
6"
$\pm\frac{1}{2}$
2" Lap
As Specified
$\frac{7}{16}$" Holes on 12" Centers-Max.
Gal. Toe Plate Same Ga. as Skirt.
3" Max.

ELEVATION



CROSS SEC. VIEW

NOTE—Toe plate to be used only when specified.

All sheet metal parts to be galvanized and same gage as Pipe-Arch Std. 41 CM. Delete rodded ends on all pipe using flared end sections.

Toe plate to be punched with 7/16" holes to match holes in skirt lip. 3/8" galvanized bolts to be furnished. Length of toe plate as shown on plans. Available standard depths - 12", 15", 18", 24", 30", 36" & 48".

Skirt section for pipe-arches with rise up to 36" incl. may be made from two sheets joined on ℄ by riveting, bolting or welding. Skirt Sect. for pipe arches with rise of 40" to 44" incl. may be made from three sheets joined at equal distances from ℄ by riveting, bolting or welding.

Where joints are welded they are to be given one coat of red lead (ASTM) and sufficient coats of aluminum paint (ASTM) to cover.

F.E.T.S. to be included in length of pipe as shown on plans.

PIPE ARCH DIMENSIONS		DIMENSIONS						
		"A"	"B"	"L"	"W"	"h"	"V"	"S"
SPAN	RISE	(Min.)	(Max.)	(2" Tol.)	(2" Tol.)	($\frac{1}{2}$" Tol.)		
18"	11"	9"	9"	22"	30"	$3\frac{3}{4}$"	14"	36"
22"	13"	9"	10"	26"	36"	$4\frac{1}{2}$"	10"	36"
25"	16"	9"	$11\frac{1}{2}$"	31"	42"	$5\frac{1}{4}$"	17"	48"
29"	18"	9"	$13\frac{3}{4}$"	36"	48"	6"	12"	48"
36"	22"	9"	16"	44"	60"	$7\frac{1}{4}$"	14"	60"
43"	27"	14"	$17\frac{1}{2}$"	54"	73"	9"	18"	72"
50"	31"	14"	20"	62"	86"	$10\frac{1}{4}$"	10"	72"
58"	36"	14"	22"	72"	100"	12"	12"	84"
65"	40"	14"	23"	80"	113"	$13\frac{1}{4}$"	16"	96"
72"	44"	14"	24"	88"	128"	$14\frac{3}{4}$"	20"	108"

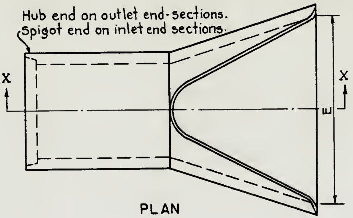
Montana State Highway Commission

APPROVED Jan. 1, 1956
STATE HIGHWAY ENGINEER

REV. 10-23-56 REV. 3-11-55

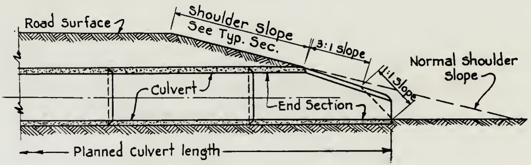
FLARED END TERMINAL SECTION
FOR REINFORCED SECTIONAL CONCRETE PIPE
(PREFABRICATED)

Montana State Highway Commission.

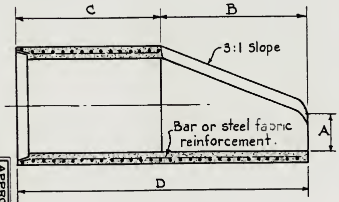


Hub end on outlet end-sections.
Spigot end on inlet end sections.
X
X
E

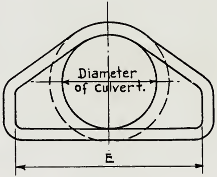
PLAN



SLOPE DETAIL



SECTION X-X



END VIEW

END- SECTION DIMENSIONS					
DIAM.	A	B	C	D	E
12"	4"	2'-0"	4'-0$\frac{7}{8}$"	6'-0$\frac{7}{8}$"	2'-0"
15"	6"	2'-3"	3'-10"	6'-1"	2'-6"
18"	9"	2'-3"	3'-10"	6'-1"	3'-0"
24"	9$\frac{1}{2}$"	3'-7$\frac{1}{2}$"	2'-6"	6'-1$\frac{1}{2}$"	4'-0"
30"	1'-0"	4'-6"	1'-7$\frac{3}{4}$"	6'-1$\frac{3}{4}$	5'-0"
36"	1'-3"	5'-3"	2'-10$\frac{3}{4}$"	8'-1$\frac{3}{4}$	6'-0"
42"	1'-9"	5'-3"	2'-11"	8'-2"	6'-6"
48"	2'-0"	6'-0"	2'-2"	8'-2"	7'-0"

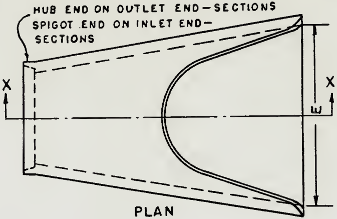
NOTE :- Reinforcing Steel & Concrete shall conform to Specifications for Reinforced Conc. Pipe.
F.E.T.S. To be included in length of pipe as shown on plans.

APPROVED Jan 1, 1956
STATE HIGHWAY ENGINEER

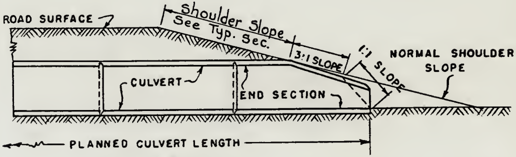
REV. 11-10-55 REV. 10-1-51
REV. 1-1-56 REV. 8-1-53

Montana State Highway Commission

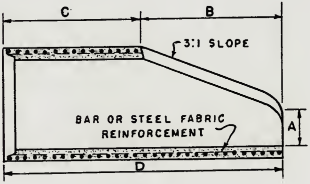
REV. 1-1-56


HUB END ON OUTLET END-SECTIONS
SPIGOT END ON INLET END-SECTIONS
X
X
E

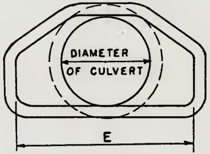
PLAN



SLOPE DETAIL



SECTION X-X



END VIEW

END SECTION DIMENSIONS					
DIAM	A	B	C	D	E
12"	4"	2'-0"	4'-0 7/8"	6'-0 7/8"	2'-0"
15"	6"	2'-3"	3'-10"	6'-1"	2'-6"
18"	9"	2'-3"	3'-10"	6'-1"	3'-0"
24"	9 1/2"	3'-7 1/2"	2'-6"	6'-1 1/2"	4'-0"
30"	1'-0"	4'-6"	1'-7 3/4"	6'-1 3/4"	5'-0"
36"	1'-3"	5'-3"	2'-10 3/4"	8'-1 3/4"	6'-0"
42"	1'-9"	5'-3"	2'-11"	8'-2"	6'-6"
48"	2'-0"	6'-0"	2'-2"	8'-2"	7'-0"

NOTE:- REINFORCING STEEL & CONCRETE SHALL CONFORM TO SPECIFICATIONS FOR REINFORCED CONC. PIPE.
F.E.T.S. TO BE INCLUDED IN LENGTH OF PIPE AS SHOWN ON PLANS.

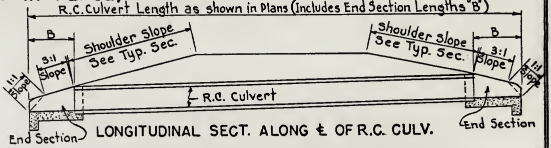
FLARED END TERMINAL SECTION
FOR REINFORCED SECTIONAL CONC. PIPE
(PREFABRICATED).

REV. 11-10-55 REV. 10-1-51

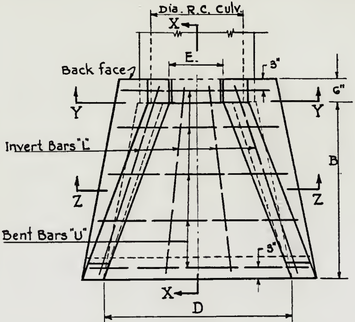
APPROVED Jan. 1, 1956
STATE HIGHWAY ENGINEER

Montana State Highway Commission

FLARED END TERMINAL SECTION FOR REINFORCED CONC. PIPE
(CAST IN PLACE)


R.C. Culvert Length as shown in Plans (Includes End Section Lengths "B")
B
Shoulder Slope See Typ. Sec.
3:1 Slope
1:1 Slope
R.C. Culvert
End Section
End Section

LONGITUDINAL SECT. ALONG ℄ OF R.C. CULV.

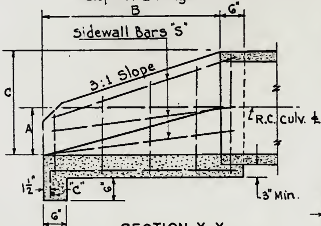


PLAN

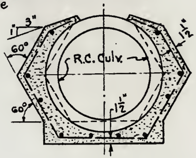
Showing Reinforcing in invert of Apron
Sidewall Reinforcing not shown.

ESTIMATE QUANTITIES							GENERAL DIMENSIONS					
CULV. DIA.	CONC.	STL.	NO. REINF. BARS.				A	B	C	D	E	T
			C	L	S	U						
12"	0.2 C.Y.	26 Lb	1	3	6	3	6"	2'-0"	1'-2"	2'-0"	6¾	6"
15"	0.3 "	35 "	1	4	6	4	7½	2'-5¼	1'-5¼	2'-6"	8¼	6"
18"	0.4 "	42 "	1	4	6	4	9"	2'-10½	1'-8½	3'-0"	9¾	6"
24"	0.6 "	58 "	1	4	6	5	12"	3'-9"	2'-3"	4'-0"	12¾	6"
30"	1.0 "	77 "	1	4	6	6	15"	4'-7½	2'-9½	5'-0"	15¾	6½
36"	1.4 "	87 "	1	4	6	6	18"	5'-6"	3'-4"	6'-0"	18	7"
42"	1.9 "	107 "	1	4	6	7	21"	6'-4½	3'-10½	6'-6"	21¼	7½
48"	2.4 "	136 "	1	5	6	8	24"	7'-3"	4'-5"	7'-0"	23¾	8"
* 60"	3.0 "	160 "	1	5	6	8	30"	6'-6"	5'-6"	7-4	30"	10"

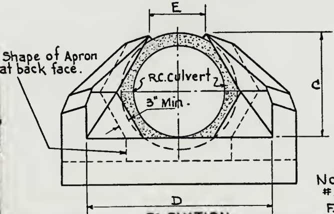
*60" Special end section is based on the slope of a wing 2:1.



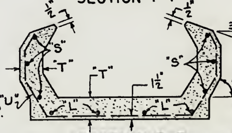
SECTION X-X



SECTION Y-Y



ELEVATION



SECTION Z-Z

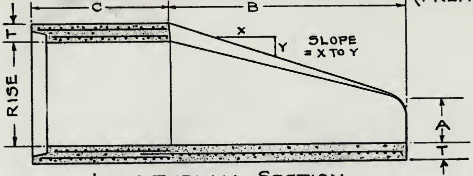
NOTE: The reinforcement steel to be #4 deformed bars. Conc. to be class "D". F.E.T.S. to be included in length of pipe as shown on plans.

APPROVED Jan. 1 1936
STATE HIGHWAY ENGINEER

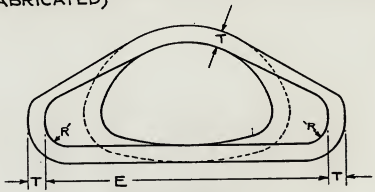
REV. 10-1-51

C72

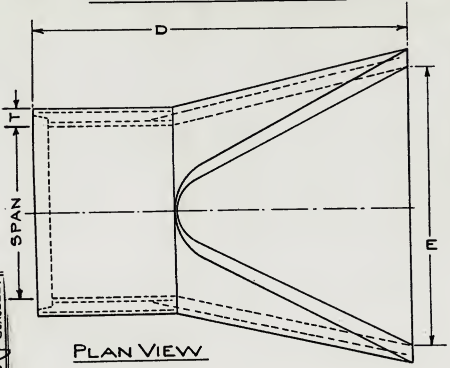
FLARED END SECTIONS FOR REINFORCED CONCRETE PIPE ARCH CULVERTS
(PREFABRICATED)



LONGITUDINAL SECTION



END VIEW



PLAN VIEW

END SECTION DIMENSIONS - INCHES										
SIZE	SPAN	RISE	A	B	C	D	E	T	R	SLOPE
24"	28½"	18"	8½"	39"	33"	72"	48"	3½"	3"	3 To 1.
30"	36¼"	22½"	9½"	50"	46"	96"	60"	.4"	3"	3 To 1
36"	43¾"	26⅝"	11⅛"	60"	36"	96"	72"	4½	6"	3 To 1
42"	51⅛"	31 5/16"	15 13/16"	60"	36"	96"	78"	4½"	6"	3 To 1
48"	58½"	36"	21"	60"	36"	96"	84"	5"	6"	3 To 1
60"	73½"	45"	31"	60"	36"	96"	96"	6"	6"	3 To 1
72"	88"	54"	31"	60"	39"	99"	120"	7"	6"	2 To 1

DESIGN OF REINFORCING STEEL & CONCRETE END SECTION SHALL CONFORM TO STANDARD REINFORCED CONCRETE ARCH CULVERTS.

F.E.T.S. TO BE INCLUDED IN LENGTH OF PIPE AS SHOWN ON PLANS.

FOR REINF. CONC. PIPE ARCH. CULVERTS SEE STD. SHEET NO. 52-RC

Montana State Highway Commission

APP. 10-18-55 BRR

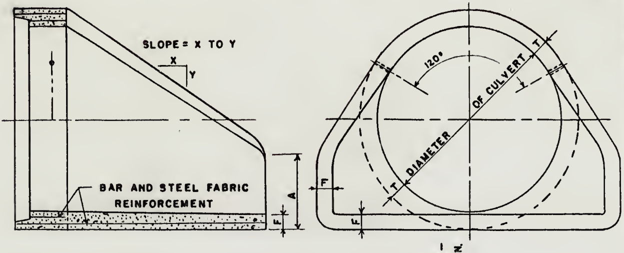
REV. 1-1-56

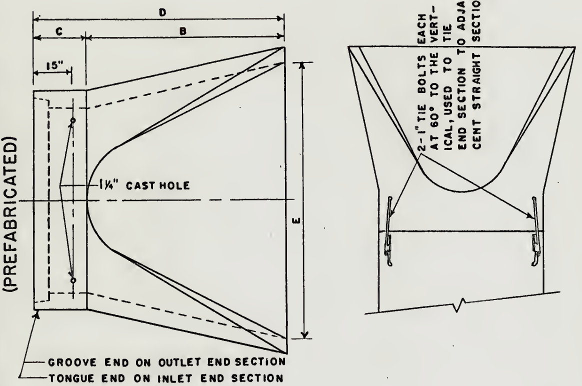
APPROVED Jan. 3, 1956
STATE HIGHWAY ENGINEER

REV. 10-5-[illegible]
REV. 8-22-55

C73

FLARED END TERMINAL SECTION FOR REINFORCED SECTIONAL CONCRETE PIPE
(PREFABRICATED)




D
C
B
15"
1¼" CAST HOLE
E
GROOVE END ON OUTLET END SECTION
TONGUE END ON INLET END SECTION
2-1" TIE BOLTS EACH AT 60° TO THE VERTICAL, USED TO TIE END SECTION TO ADJACENT STRAIGHT SECTION.

DIA.	SLOPE	T	A	B	C	D	E	F
60"	2 TO 1	6"	2'-11"	5'-0"	3'-3"	8'-3"	8'-0"	5"
72"	1.86 TO 1	7"	3'-0"	6'-6"	1'-9"	8'-3"	9'-0"	6"
84"	1.5 TO 1	8"	3'-0"	7'-6.5"	1'-9"	9'-3.5"	10'-0"	6.5"

NOTE: *Reinforcing Steel & Concrete shall conform to Specifications for Reinforced Conc. Pipe. F.E.T.S. To be included in length of pipe as shown on plans.*

TIE BOLTS TO BE USED ON 72" AND 84" FLARED END SECTIONS

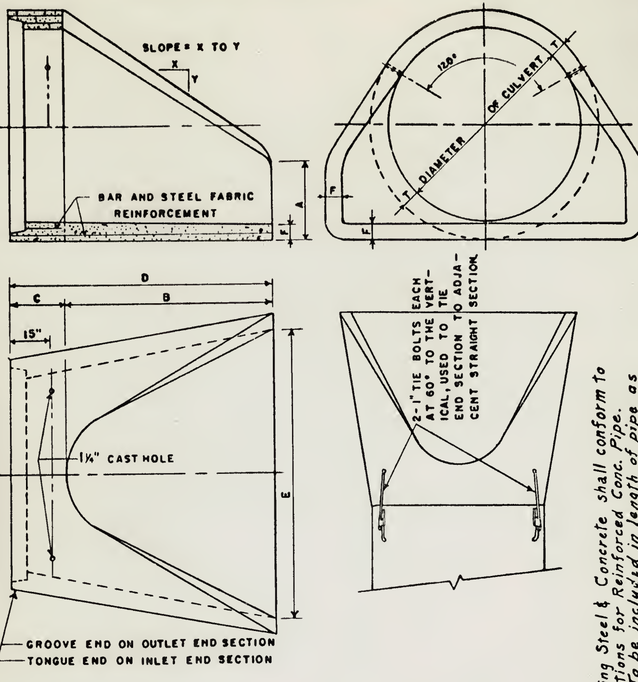
3 TIE BOLTS, ONE AT THE TOP AND ONE ON EACH SIDE AT THE HORIZONAL, MAY BE USED IF REQUIRED.

APPROVED Jan. 1, 1956
Scott P. Hart
STATE HIGHWAY ENGINEER

Montana State Highway Commission

REV. 1-1-56

FLARED END TERMINAL SECTION FOR REINFORCED SECTIONAL CONCRETE PIPE
(PREFABRICATED)


SLOPE = X TO Y
X
Y
BAR AND STEEL FABRIC REINFORCEMENT
A
F
120°
T
DIAMETER OF CULVERT
T
F
F
D
C
B
15"
1¼" CAST HOLE
E
GROOVE END ON OUTLET END SECTION
TONGUE END ON INLET END SECTION
2-1" TIE BOLTS EACH AT 60° TO THE VERTICAL, USED TO TIE END SECTION TO ADJACENT STRAIGHT SECTION

NOTE: Reinforcing Steel & Concrete shall conform to Specifications for Reinforced Conc. Pipe. F.E.T.S. To be included in length of pipe as shown on plans.

DIA.	SLOPE	T	A	B	C	D	E	F
60"	2 TO 1	6"	2'-11"	5'-0"	3'-3"	8'-3"	8'-0"	5"
72"	1.86 TO 1	7"	3'-0"	6'-6"	1'-9"	8'-3"	9'-0"	6"
84"	1.5 TO 1	8"	3'-0"	7'-6.5"	1'-9"	9'-3.5"	10'-0"	6.5"

TIE BOLTS TO BE USED ON 72" AND 84" FLARED END SECTIONS

3 TIE BOLTS, ONE AT THE TOP AND ONE ON EACH SIDE AT THE HORIZONAL, MAY BE USED IF REQUIRED.

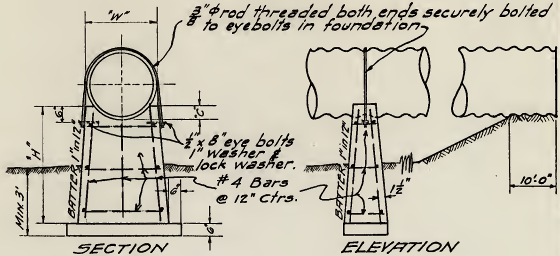
(NOT PATENTED)

APPROVED Jan. 4, 1956
Scott P. Hart
STATE HIGHWAY ENGINEER

Montana State Highway Commission

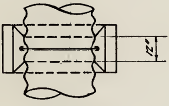
8-16-56

SUPPORTS FOR CORRUGATED METAL PIPES CARRYING IRRIGATION WATER ACROSS BORROW PITS


$\frac{3}{8}$"φ rod threaded both ends securely bolted to eyebolts in foundation
"W"
"C"
6"
"H"
MIN. 3'
BATTER 1" in 12"
$\frac{1}{2}$" x 8" eye bolts 1" Washer & lock washer.
#4 Bars @ 12" Ctrs.
6"
6"
BATTER 1" in 12"
$1\frac{1}{2}$"
10'-0"

SECTION

ELEVATION



PLAN

NOTE:- All hardware and reinf. steel to be absorbed in the Unit price bid for cu. yd. of concrete.

DIAMETER OF *PIPE	MAX. SPAN OF PIPE C. to C. OF SUPPORTS	"W"	"C"	CUBIC YARDS CLASS "AD" CONC. IN ONE SUPPORT - FOR DIFFERENT VALUES OF "H"					
				3'	4'	5'	6'	7'	8'
18"	20'	20"	3"	.35	.50	.67	.87	1.10	1.36
24"	18'	24"	4"	.40	.57	.76	.99	1.24	1.54
30"	16'	30"	5"	.48	.67	.90	1.17	1.46	1.80
36"	16'	36"	6"	.55	.78	1.04	1.34	1.68	2.06
42"	14'	42"	7"	.62	.88	1.18	1.52	1.89	2.31
48"	12'	48"	8"	.69	.99	1.32	1.69	2.11	2.57

* NOTE: All irrigation pipe to be Syphon Pipe (close riveted and soldered water-tight.)

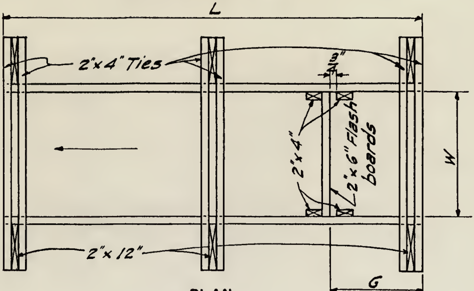
APPROVED Jan. 1 1956
Scott P. Hart
STATE HIGHWAY ENGINEER

Montana State Highway Commission

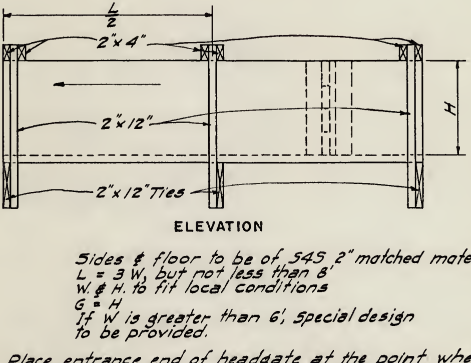
REV. 10-1-51

HG

WOOD IRRIGATION DITCH HEAD GATE



PLAN



ELEVATION

Sides & floor to be of S4S 2" matched material.
L = 3 W, but not less than 8'
W. & H. to fit local conditions
G = H
If W is greater than 6', Special design to be provided.

NOTE:- Place entrance end of headgate at the point where the high water line in the canal intersects the canal bank. In soils that are easily eroded, it may be necessary to extend the planking in the bottom & sides of the headgate to an intersection with the canal bank.

BILL OF MATERIAL

W = 1'-2"	H = 2'	180 FBM – (18")
W = 1'-8"	H = 2'	190 FBM – (24")
W = 2'-2"	H = 3'	250 FBM – (30")
W = 2'-8"	H = 3'	270 FBM – (36")

Use 12d. nails. Nails to be included in price bid for lumber.

Montana State Highway Commission

APPROVED Jan. 1, 1956
Scott P. Hart
STATE HIGHWAY ENGINEER

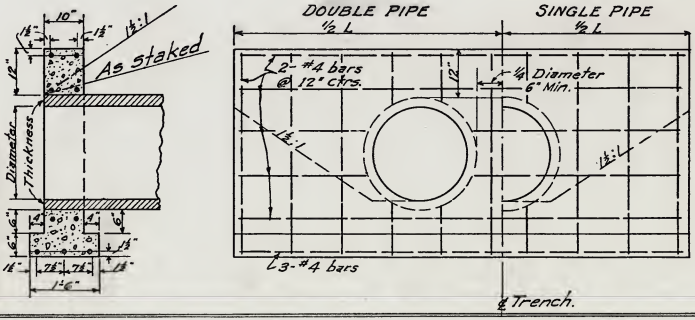
REV. 10-1-51
REV. 1-1-56

CONCRETE HEADWALLS FOR PIPE CULVERTS

CUBIC YARDS OF CLASS "AD" CONCRETE

DIAM. OF PIPE	SINGLE CORR. METAL				DOUBLE CORR. METAL				DIAM. OF PIPE	THICKNESS OF SHELL	SINGLE CONC. PIPE				DOUBLE CONC. PIPE			
	AREA SQ. FT. 1 PIPE	L	CU. YDS ONE HDWL	CU. YDS TWO HDWLS	AREA SQ. FT. 2 PIPES	L	CU. YDS ONE HDWL	CU. YDS TWO HDWLS.			OUTSIDE AREA SQ. FT. 1 PIPE	L	CU. YDS. ONE HDWL	CU. YDS TWO HDWLS	OUTSIDE AREA SQ. FT. 2 PIPES	L	CU. YDS. ONE HDWL	CU. YDS. TWO HDWLS
18"	1.767	6'-0"	0.67	1.34	3.534	8'-3"	0.88	1.77	18"	2½"	2.885	6'-0"	0.71	1.42	5.770	8'-8"	0.98	1.95
24"	3.142	8'-0"	0.99	1.98	6.284	11'-0"	1.30	2.60	24"	3"	4.909	8'-0"	1.06	2.12	9.818	11'-6"	1.44	2.87
30"	4.908	10'-0"	1.36	2.72	9.816	13'-9"	1.78	3.55	30"	3½"	7.467	10'-0"	1.46	2.92	14.934	14'-4"	2.10	4.20
36"	7.068	12'-0"	1.78	3.56	14.136	16'-6"	2.32	4.63	36"	4"	10.559	12'-0"	1.92	3.84	21.118	17'-2"	2.56	5.12
42"	9.621	14'-0"	2.25	4.50	19.242	19'-3"	2.91	5.82	42"	4½"	14.186	14'-0"	2.44	4.87	28.372	20'-0"	3.23	6.46
48"	12.566	16'-0"	2.77	5.54	25.132	22'-0"	3.57	7.14	48"	5"	18.348	16'-0"	3.01	6.01	36.696	22'-10"	3.96	7.93
60"	19.635	20'-0"	3.96	7.92	39.270	27'-6"	5.07	10.14	60"	6"	28.274	20'-0"	4.31	8.62	54.548	28'-6"	5.64	11.29

NOTE :- Reinforcing as indicated shall be included in the unit price bid for concrete. Length of bars = L - 6". All exposed edges of concrete to be chamfered 1".

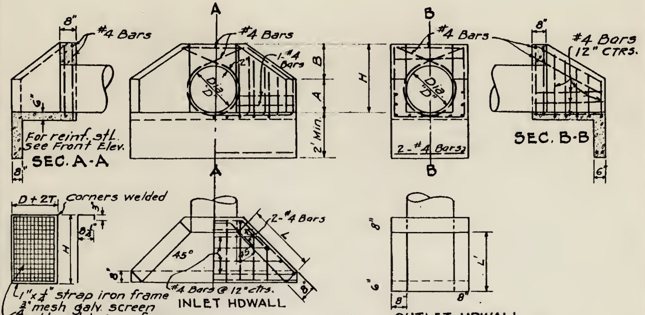


APPROVED Jan 4 1956
STATE HIGHWAY ENGINEER

Montana State Highway Commission

REV. 10-1-51

INLET & OUTLET HEADWALLS FOR C.M.P.



Inlet screen (Not to be used unless recommended by the Eng.) Screen to be absorbed in the unit price bid for Lin. Ft. of pipe.

D = Inside Diam.
T = Thickness of shell

All exposed corners of concrete to be chamfered 1". Reinforcing steel to be not less than 1½" to nearest face of concrete.

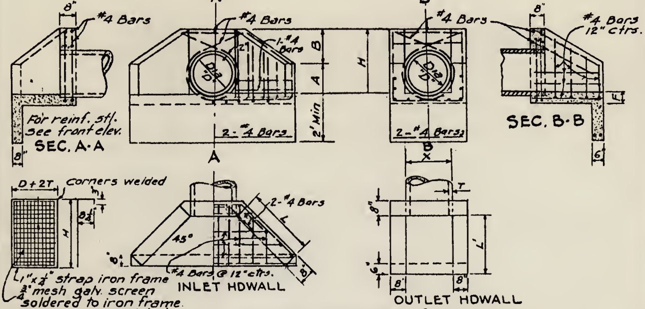
INLET & OUTLET HEADWALLS FOR C.M.P.											
CULVERT			CL. AD CONC CU. YDS.		REINF. STL. LBS.		DIMENSION TABLE				
DIA. "D"	AREA SQ.FT.		INLET	OUTLET	INLET	OUTLET	L	L'	A	B	H
18"	1.77		.73	.59	62	50	2'-6"	2'-2"	1'-3"	1'-3"	2'-6"
24"	3.14		.91	.76	82	54	3'-0"	2'-6"	1'-6"	1'-6"	3'-0"
30"	4.91		1.06	.95	99	66	3'-6"	2'-10"	1'-9"	1'-9"	3'-6"
36"	7.07		1.68	1.11	116	82	4'-0"	3'-2"	2'-0"	2'-0"	4'-0"
42"	9.62		2.10	1.40	139	105	4'-6"	3'-6"	2'-3"	2'-3"	4'-6"
48"	12.57		2.32	1.66	162	124	5'-0"	3'-10"	2'-6"	2'-6"	5'-0"

Reinforcing steel as indicated to be included in the unit price bid per cu. yd. of conc.

APPROVED Jan. 4, 1956
Scott P. Hart
STATE HIGHWAY ENGINEER

REV. 10-1-51

INLET & OUTLET HEADWALLS FOR R.C.P.



Inlet screen (Not to be used unless recommended by the Eng.) Screen to be absorbed in the unit price bid for Lin. Ft. of pipe

All exposed corners of concrete to be chamfered 1". Reinforcing steel to be not less than 1½" to nearest face of concrete.

INLET & OUTLET HEADWALLS FOR R.C.P.											
CULVERT		CL. "AD" CONC. CU. YDS.		REINF. STEEL LBS.		DIMENSION TABLE					
DIA. "D"	AREA SQ. FT.	INLET	OUTLET	INLET	OUTLET	L.	L'	A	B	X	F
18"	1.77	.80	.60	65	53	2'-6"	2'-2"	1'-3"	1'-3"	1'-11"	6½"
24"	3.14	1.00	.86	85	69	3'-0"	2'-6"	1'-6"	1'-6"	2'-6"	7"
30"	4.91	1.42	1.14	104	85	3'-6"	2'-10"	1'-9"	1'-9"	3'-1"	7½"
36"	7.07	1.84	1.43	126	101	4'-0"	3'-2"	2'-0"	2'-0"	3'-8"	8"
42"	9.62	2.12	1.73	150	117	4'-6"	3'-6"	2'-3"	2'-3"	4'-3"	8½"
48"	12.57	2.34	2.07	175	134	5'-0"	3'-10"	2'-6"	2'-6"	4'-10"	9"

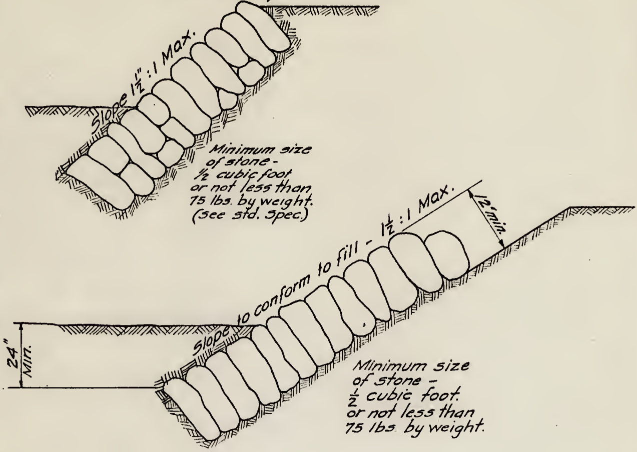
Reinforcing steel as indicated to be included in the Unit price bid per cu. yd. of concrete.

APPROVED Jan. 1, 1956
Scott P. Hart
STATE HIGHWAY ENGINEER

REV. 10-1-51

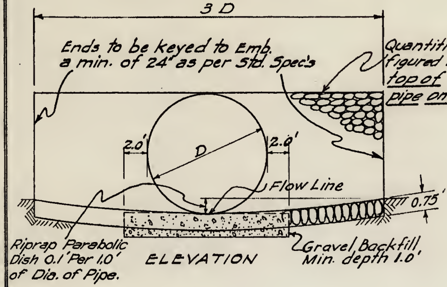
HAND LAID RIPRAP

Scale - 3/8" = 1'-0"
See Std. Specifications.


Slope $1\frac{1}{2}$:1 Max.
Minimum size of stone - ½ cubic foot or not less than 75 lbs. by weight. (see std. Spec.)
Slope to conform to fill - $1\frac{1}{2}$: 1 Max.
12" min.
24" Min.
Minimum size of stone - ½ cubic foot. or not less than 75 lbs by weight.

APPROVED Jan. 1 1956
Scott P. Hart
STATE HIGHWAY ENGINEER

GROUTED RIPRAP HEADWALLS FOR STR. PL. PIPE CULVERTS

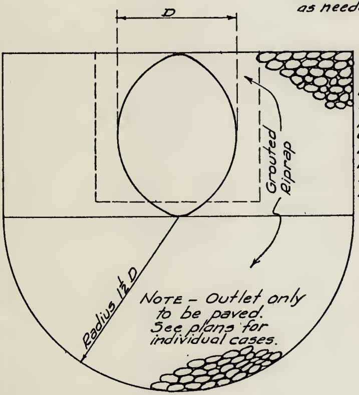

3 D
Ends to be keyed to Emb. a min. of 24" as per Std. Spec's
Quantities figured to top of pipe only.
2.0'
D
2.0'
Flow Line
0.75'
Riprap Parabolic Dish 0.1' Per 1.0' of Dia. of Pipe.
Gravel Backfill, Min. depth 1.0'

ELEVATION

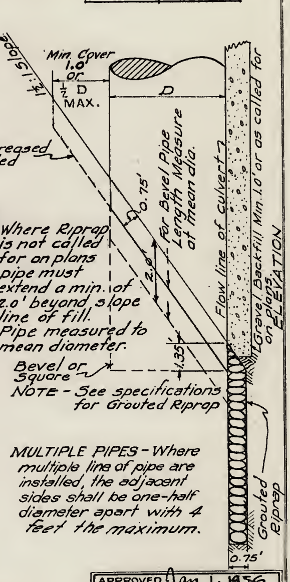
QUANTITIES	
DIA. PIPE	S.Y. RIPRAP
84	73.9
90	84.0
96	94.7
102	106.1
108	118.1
114	130.7
120	144.0
126	157.9
132	172.5
138	187.7
144	203.5
150	220.0
156	237.1
162	254.9
168	273.3
174	292.3
180	312.0
210	420.0

NOTE –
D = Dia. of pipe

Quantities figured for 2 Hdwalls. & 1 apron for outlet.
Grouted Riprap shall not be placed until the embankment has settled to a stable foundation.


D
Grouted Riprap
Radius 1½ D
NOTE – Outlet only to be paved. See plans for individual cases.

PLAN


1½:1 Slope
Min. Cover 1.0' or ½ D MAX.
D
To be increased as needed
0.75'
For Bevel Pipe Length Measure at mean dia.
2.0'
1.35'
Flow line of culvert
Gravel Backfill Min. 1.0' or as called for on plans.
Bevel or Square
Grouted Riprap
0.75'

ELEVATION

Where Riprap is not called for on plans pipe must extend a min. of 2.0' beyond slope line of fill. Pipe measured to mean diameter.

NOTE – See specifications for Grouted Riprap

MULTIPLE PIPES – Where multiple line of pipe are installed, the adjacent sides shall be one-half diameter apart with 4 feet the maximum.

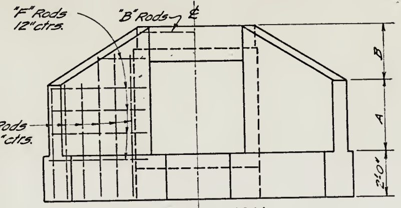
For any size pipe – Area Sq. Yds. to top of pipe only = $1.279906 D^2 + 1.602468 D$ Where D = Dia. of pipe in feet.

APPROVED Jan. 1, 1956
Scott P. Hart
STATE HIGHWAY ENGINEER

REV. 1-1-56
REV. 5-1-48
REV. 10-1-51

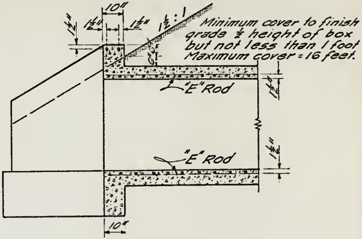
REINFORCED CONCRETE BOX CULVERTS

Montana State Highway Commission



ELEVATION

Minimum length of culvert (out to out of headwall) = crown of roadway plus 4 feet.


10"
1½"
1½"
1½"
1½ : 1
6"
Minimum cover to finish grade ½ height of box but not less than 1 foot
Maximum cover = 16 feet.
"E" Rod
1¾"
"E" Rod
1¾"
10"

LONGITUDINAL SECTION

Notes:

Footings to be carried deeper if required by the Engineer.

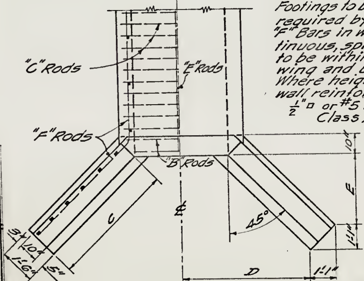
"F" Bars in wing and barrel to be continuous, splicing of bars in no case to be within 3'-0" of junction of wing and barrel.

Where height is 2'-0" or less, no wall reinforcing is to be used.

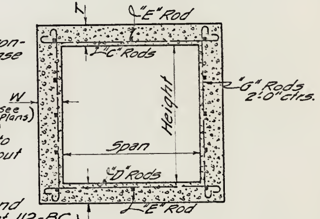
½" □ or #5 rods used throughout (See Plans)

Class "AD" concrete (See Plans)

All exposed corners to be chamfered throughout



PLAN



For dimensions and quantities see Sheet 112-BC

CROSS SECTION

NOTE:- Where box is specified to be lengthened see Std. sheet 115-BC

Design LL - H.15

Note:- This sheet for historical reference only. Not to be used for design.

APPROVED Jan. 1, 1956
STATE HIGHWAY ENGINEER

REV. 10-1-51 REV. 5-1-48
REV. 10-3-56 REV. 12-15-49

C4

111

DIMENSIONS AND QUANTITIES FOR REINFORCED CONCRETE BOX CULVERTS WITH WING HEADWALLS

NOTE: Quantities tabulated for reinf. steel in std. are for ½"□.
Increase quantities by 22.7 % for #5 bars

HEIGHT	SPAN	T	W	Headwall Dimensions					BARS IN HEADWALL					BARS IN BARREL							CU.YDS. CONC. IN 2 HDWLS.	LBS. STEEL IN 2 HDWLS.	Barrel per Lin. Ft.	
									"A" RODS		"B" RODS	"F" RODS		"C" Rods		"D" Rods		"E"	"F"	"G"			CU.YDS. CONC.	LBS. STEEL
				A	B	C	D	E	No.	Lgth.	No./Lgth.	No.	Lgth.	Spacing	Lgth.	Spacing	Lgth.	No. 24" ctr.	No. 12" ctr.	Lgth. 24" ctr.				
1'-6"	2'-0"	6"	6"	1'-9"	1'-3"	2'-6"	2'-5¾"	1'-0⅛"	6	3'-6"	2/2'-6"	2/2	2'-0"/2'-6"	9"	2'-9"	12"	2'-9"	2	4	0	2.54	59.5	.167	10.8
1'-6"	3-0	6	6	1-9	1-3	2-6	2-11¾	1-0⅛	6	3-6	2/3-6	2/2	2-0/2-6	8	3-9	11	3-9	2	4	0	2.76	62.9	.204	13.3
1'-6"	4-0	7	6	1-9	1-4	2-8	3-7⅛	1-1½	6	3-6	2/4-6	2/2	2-0/2-8	7	4-9	10	4-9	2	4	0	3.14	66.9	.271	16.7
1'-6"	5-0	8	6	1-9	1-5	2-10	4-2½	1-2⅞	6	3-6	2/5-6	2/2	2-0/2-10	6	5-9	9	5-9	2	4	0	3.52	70.8	.352	21.1
1'-6"	6-0	9	6	1-9	1-6	3-0	4-10	1-4⅜	6	3-6	2/6-6	2/2	2-0/3-0	5	6-9	8	6-9	2	4	0	3.92	74.8	.444	27.2
2'-0"	2-0	6	6	2-0	1-6	3-0	2-10	1-4⅜	8	4-0	2/2-6	2/4	2-6/3-0	9	2-9	12	2-9	2	4	0	3.07	91.8	.185	10.8
2'-0"	3-0	6	6	2-0	1-6	3-0	3-4	1-4⅜	8	4-0	2/3-6	2/4	2-6/3-0	8	3-9	11	3-9	2	4	0	3.29	95.2	.222	13.3
2'-0"	4-0	7	6	2-0	1-7	3-2	3-11½	1-5⅞	8	4-0	2/4-6	2/4	2-6/3-2	7	4-9	10	4-9	2	4	0	3.67	99.7	.290	16.7
2'-0"	5-0	8	6	2-0	1-8	3-4	4-6¾	1-7⅛	8	4-0	2/5-6	2/4	2-6/3-4	6	5-9	9	5-9	2	4	0	4.07	104.3	.370	21.1
2'-0"	6-0	9	6	2-0	1-9	3-6	5-2¼	1-8⅝	8	4-0	2/6-6	2/4	2-6/3-6	5	6-9	8	6-9	2	4	0	4.48	108.8	.463	27.2
3'-0"	3-0	6	7	2-6	2-0	4-0	4-0½	2-0⅞	6/4	4-6/5-6	2/3-6	2/6	2-6/4-0	8	3-11	11	3-11	2	8	3'-9"	4.48	144.5	.284	20.5
3'-0"	4-0	7	7	2-6	2-1	4-2	4-8	2-2⅜	6/4	4-6/5-6	2/4-6	2/6	2-6/4-2	7	4-11	10	4-11	2	8	3-11	4.89	149.6	.353	24.1
3'-0"	5-0	8	7	2-6	2-2	4-4	5-3¼	2-3⅝	6/4	4-6/5-6	2/5-6	2/6	2-6/4-4	6	5-11	9	5-11	4	8	4-1	5.31	154.7	.434	30.5
3-0	6-0	9	7	2-6	2-3	4-6	5-10¾	2-5⅛	6/4	4-6/5-6	2/6-6	2/6	2-6/4-6	5	6-11	8	6-11	4	8	4-3	5.74	159.8	.528	36.8
3-0	7-0	10	7	2-6	2-4	4-8	6-6⅛	2-6½	6/4	4-6/5-6	2/7-6	2/6	2-6/4-8	4	7-11	7	7-11	6	8	4-5	6.20	164.9	.634	47.4
3-0	8-0	11	7	2-6	2-5	4-10	7-1½	2-7⅞	6/4	4-6/5-6	2/8-6	2/6	2-6/4-10	3	8-11	6	8-11	6	8	4-7	6.65	170.0	.752	61.0
4-0	4-0	7	8	3-0	2-7	5-2	5-4⅜	2-10¾	6/6	5-0/6-0	2/4-6	2/8	2-6/5-2	7	5-1	10	5-1	2	10	4-11	6.32	206.3	.428	27.2
4-0	5-0	8	8	3-0	2-8	5-4	5-11¾	3-0⅛	6/6	5-0/6-0	2/5-6	2/8	2-6/5-4	6	6-1	9	6-1	4	10	5-1	6.76	211.9	.510	33.6
4-0	6-0	9	8	3-0	2-9	5-6	6-7⅛	3-1½	6/6	5-0/6-0	2/6-6	2/8	2-6/5-6	5	7-1	8	7-1	4	10	5-3	7.22	217.6	.605	40.0
4-0	7-0	10	8	3-0	2-10	5-8	7-2½	3-2⅞	6/6	5-0/6-0	2/7-6	2/8	2-6/5-8	4	8-1	7	8-1	6	10	5-5	7.68	223.3	.712	59.2
4-0	8-0	11	8	3-0	2-11	5-10	7-10	3-4⅜	6/6	5-0/6-0	2/8-6	2/8	2-6/5-10	3	9-1	6	9-1	6	10	5-7	8.16	228.9	.831	64.5
5-0	5-0	8	9	3-6	3-2	6-4	6-8¼	3-8⅝	8/6	5-6/6-6	2/5-6	2/10	2-6/6-4	6	6-3	9	6-3	4	12	6-1	8.41	276.0	.599	36.7
5-0	6-0	9	9	3-6	3-3	6-6	7-3⅝	3-10	8/6	5-6/6-6	2/6-6	2/10	2-6/6-6	5	7-3	8	7-3	4	12	6-3	8.89	282.2	.694	43.2
5-0	7-0	10	9	3-6	3-4	6-8	7-11⅛	3-11½	8/6	5-6/6-6	2/7-6	2/10	2-6/6-8	4	8-3	7	8-3	6	12	6-5	9.37	288.4	.802	54.0
5-0	8-0	11	9	3-6	3-5	6-10	8-6½	4-0⅞	8/6	5-6/6-6	2/8-6	2/10	2-6/6-10	3	9-3	6	9-3	6	12	6-7	9.86	294.7	.923	67.9
6-0	4-0	7	10	4-0	3-7	7-2	6-9¼	4-3⅝	8/8	6-0/7-0	2/4-6	2/12	2-6/7-2	7	5-5	10	5-5	2	14	6-11	9.76	346.8	.615	33.3
6-0	5-0	8	10	4-0	3-8	7-4	7-4¾	4-5⅛	8/8	6-0/7-0	2/5-6	2/12	2-6/7-4	6	6-5	9	6-5	4	14	7-1	10.25	353.6	.700	39.8
6-0	6-0	9	10	4-0	3-9	7-6	8-0⅛	4-6½	8/8	6-0/7-0	2/6-6	2/12	2-6/7-6	5	7-5	8	7-5	4	14	7-3	10.75	360.4	.797	46.4
6-0	7-0	10	10	4-0	3-10	7-8	8-7½	4-7⅞	8/8	6-0/7-0	2/7-6	2/12	2-6/7-8	4	8-5	7	8-5	6	14	7-5	11.25	367.2	.905	57.3
6-0	8-0	11	10	4-0	3-11	7-10	9-2⅞	4-9¼	8/8	6-0/7-0	2/8-6	2/12	2-6/7-10	3	9-5	6	9-5	6	14	7-7	11.64	374.0	1.027	71.4
7-0	6-0	9	11	4-6	4-3	9-0	9-1	5-7¼	10/10	6-6/8-9	2/6-6	2/14	2-6/9-0	5	7-7	8	7-7	4	16	8-3	13.46	504.0	.910	49.1

NOTE: - This sheet for historical reference only. Not to be used for design.

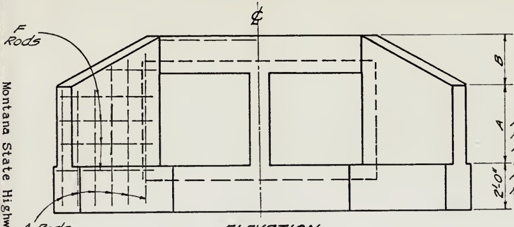
Note-Subtract 10" from Length of barrel for each headwall and multiply by cu. yds. and lbs. per foot.
Quantities for Estimating purposes only.
Design LL - H-15

Montana State Highway Commission.

APPROVED Jan. 1, 1956
Scott P. Hart
STATE HIGHWAY ENGINEER

REV. 10-3-56 REV. 12-15-49
REV. 10-1-51

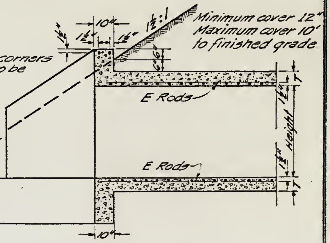
REINFORCED CONCRETE DOUBLE BOX CULVERT



ELEVATION

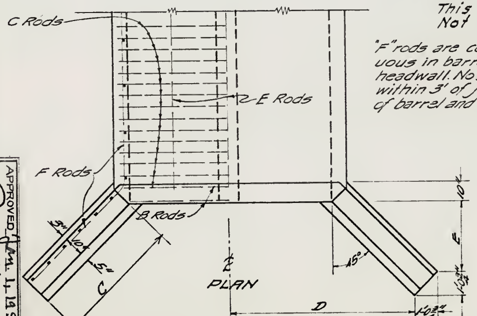
All exposed corners of concrete to be chamfered.

Note:
Headwall foundations to be carried deeper or spread as required by the Engineer



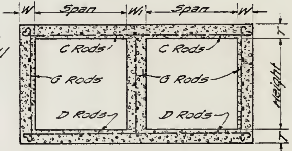
LONGITUDINAL SECTION

NOTE:- LENGTHENING – See Std. 115 BC
This sheet for historical reference only.
Not to be used for design.



PLAN

"F" rods are continuous in barrel and headwall. No splices within 3' of junction of barrel and headwall



CROSS SECTION

Note:
Minimum length of Culvert (out to out of headwalls) = Crown of roadway, plus 4 feet.

Class "AD" concrete (See Plans).

½" □ or #5 rods throughout. (See Plans)
For dimensions and quantities see Std. 114-BC
Design LL-H-15

Montana State Highway Commission.

APPROVED Jan. 1, 1956
Fred Q. Quinn
STATE HIGHWAY ENGINEER

REV. 10-1-51 REV. 5-1-48
REV. 10-3-56 REV. 12-16-49

C4a

DIMENSIONS AND QUANTITIES FOR REINFORCED CONCRETE DOUBLE BOX CULVERTS WITH WING HEADWALLS

HEIGHT	SPAN	W	W1	T	A	B	C	D	E	BARS IN HEADWALLS						BARS IN BARREL							1 HEADWALL		2 HEADWALLS		BARREL PER LIN. FT.	
										A 12" ctr.		B	F 12" ctr.		G	C		D		E	F	G	CONC.	STEEL	CONC.	STEEL	CONC.	STEEL
										No.	Lgth.	No./Lgth.	No.	Lgth.	No./Lgth.	Spacing	Lgth.	Spacing	Lgth.	No. 24"c	No. 12"c	Lgth. 24"c	YDS.	LBS.	YDS.	LBS.	YDS.	LBS.
2'-0"	4'-0"	6"	9"	7"	2'-0"	1'-7"	3'-2"	6'-4"	1'-5⅛"	8	4'-0"	2/9'-0"	4/2	3'-2"/2'-6"	1/5'-4"	7	9'-6"	10	9-6	7	6	0	2.41	62.1	4.82	124.1	0.548	33.94
2-0	5-0	6	9	8	2-0	1-8	3-4	7-5¼	1-7⅛	8	4-0	2/11-0	4/2	3-4/2-6	1/5-4	6	11-6	9	11-6	11	6	0	2.73	66.0	5.47	132.0	0.709	47.48
2-0	6-0	6	9	9	2-0	1-9	3-6	8-6¾	1-8⅝	8	4-0	2/13-0	4/2	3-6/2-6	1/5-4	5	13-6	8	13-6	11	6	0	3.07	70.0	6.14	140.0	0.894	58.78
3-0	3-0	7	9	6	2-6	2-0	4-0	5-11	2-0⅞	6/4	4-6/5-6	2/7-0	6/2	4-0/2-6	1/6-3	8	7-8	11	7-8	7	8	3'-9"	2.72	83.5	5.43	167.0	0.507	34.35
3-0	4-0	7	9	7	2-6	2-1	4-2	7-0½	2-2⅜	6/4	4-6/5-6	2/9-0	6/2	4-2/2-6	1/6-3	7	9-8	10	9-8	7	8	3-11	3.04	87.8	6.08	175.5	0.643	41.42
3-0	5-0	7	9	8	2-6	2-2	4-4	8-1¾	2-3⅝	6/4	4-6/5-6	2/11-0	6/2	4-4/2-6	1/6-3	6	11-8	9	11-8	11	8	4-1	3.37	92.0	6.75	184.0	0.800	54.32
3-0	6-0	7	9	9	2-6	2-3	4-6	9-3¼	2-5⅛	6/4	4-6/5-6	2/13-0	6/2	4-6/2-6	1/6-3	5	13-8	8	13-8	11	8	4-3	3.72	96.3	7.44	192.5	0.987	66.87
3-0	7-0	7	9	10	2-6	2-4	4-8	10-4⅝	2-6½	6/4	4-6/5-6	2/15-0	6/2	4-8/2-6	1/6-3	4	15-8	7	15-8	15	8	4-5	4.08	100.5	8.16	201.0	1.195	87.21
3-0	8-0	7	9	11	2-6	2-5	4-10	11-6	2-7⅞	6/4	4-6/5-6	2/17-0	6/2	4-10/2-6	1/6-3	3	17-8	6	17-8	15	8	4-7	4.45	104.8	8.90	209.5	1.430	114.77
4-0	4-0	8	10	7	3-0	2-7	5-2	7-9⅜	2-10¾	6/6	5-0/6-0	2/9-1	8/2	5-2/2-6	1/7-4	7	9-9	10	9-9	7	10	4-11	3.78	117.2	7.56	234.3	0.762	44.71
4-0	5-0	8	10	8	3-0	2-8	5-4	8-10¾	3-0⅛	6/6	5-0/6-0	2/11-1	8/2	5-4/2-6	1/7-4	6	11-9	9	11-9	11	10	5-1	4.13	121.7	8.29	243.4	0.921	57.64
4-0	6-0	8	10	9	3-0	2-9	5-6	10-0⅛	3-1½	6/6	5-0/6-0	2/13-1	8/2	5-6/2-6	1/7-4	5	13-9	8	13-9	11	10	5-3	4.49	126.2	9.01	252.4	1.109	70.23
4-0	7-0	8	10	10	3-0	2-10	5-8	11-1½	3-2⅞	6/6	5-0/6-0	2/15-1	8/2	5-8/2-6	1/7-4	4	15-9	7	15-9	15	10	5-5	4.85	130.8	9.73	261.5	1.319	90.62
4-0	8-0	8	10	11	3-0	2-11	5-10	12-3	3-4⅜	6/6	5-0/6-0	2/17-1	8/2	5-10/2-6	1/7-4	3	17-9	6	17-9	15	10	5-7	5.23	135.3	10.50	270.6	1.554	118.62
5-0	5-0	9	12	8	3-6	3-2	6-4	9-8¼	3-8⅝	8/6	5-6/6-6	2/11-3	10/2	6-4/2-6	1/8-5	6	12-3	9	12-3	11	12	6-1	5.00	154.9	10.08	309.8	1.079	62.12
5-0	6-0	9	12	9	3-6	3-3	6-6	10-9⅝	3-10	8/6	5-6/6-6	2/13-3	10/2	6-6/2-6	1/8-5	5	14-3	8	14-3	11	12	6-3	5.37	159.7	10.82	319.5	1.269	74.95
5-0	7-0	9	12	10	3-6	3-4	6-8	11-11⅛	3-11½	8/6	5-6/6-6	2/15-3	10/2	6-8/2-6	1/8-5	4	16-3	7	16-3	15	12	6-5	5.75	164.5	11.57	329.1	1.483	95.67
5-0	8-0	9	12	11	3-6	3-5	6-10	13-0½	4-0⅞	8/6	5-6/6-6	2/17-3	10/2	6-10/2-6	1/8-5	3	18-3	6	18-3	15	12	6-7	6.23	169.4	12.35	338.7	1.717	123.86
6-0	6-0	9	12	9	4-0	3-9	7-6	11-6⅛	4-6½	8/8	6-0/7-0	2/13-3	12/2	7-6/2-6	1/9-6	5	14-3	8	14-3	12	14	7-3	6.31	199.8	12.74	399.5	1.361	78.90
6-0	7-0	9	12	10	4-0	3-10	7-8	12-7½	4-7⅞	8/8	6-0/7-0	2/15-3	12/2	7-8/2-6	1/9-6	4	16-3	7	16-3	16	14	7-5	6.67	204.9	13.51	409.7	1.576	99.62
6-0	8-0	9	12	11	4-0	3-11	7-10	13-8⅜	4-9¼	8/8	6-0/7-0	2/17-3	12/2	7-10/2-6	1/9-6	3	18-3	6	18-3	16	14	7-7	7.10	210.0	14.29	419.9	1.815	127.82

NOTE:- All rods ½" □ or #5 (See Plans). Theoretical weight = 0.85 lbs. per ft. for ½" □ for all computations. No allowance made for splices.
Quantities tabulated for reinf. stl. in std. are for ½" □. Increase quantities by 22.7 % for #5 bars
Quantities are for estimating purposes only.
Design L.L. - H-15
This sheet for historical reference only. Not to be used for design.

Montana State Highway Commission.

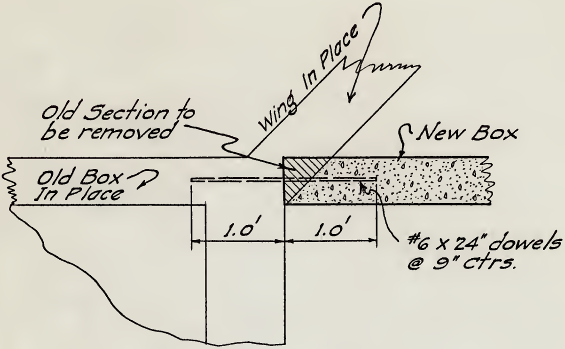
REV. 10-3-56

APPROVED Jan. 4, 1956
STATE HIGHWAY ENGINEER

REV. 12-15-49
REV. 10-1-51

114
C4a

DETAIL FOR LENGTHENING EXISTING RE-CONC. BOX CULVERT.



Note:- Doweling as shown to be used where top, sides and bottom of new box join that of the old. Curb to be removed if necessary. Dowels to be included in the unit price bid for reinf. steel.

APPROVED Jan. 1 1936
Scott P. Hart
STATE HIGHWAY ENGINEER

Montana State Highway Commission.

REV. 10-1-51

116 - S9
117 - S10
118 - S11

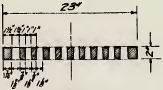
REINF. CONC. BOX CULV.

FOR DETAILED PRINTS
WRITE OFFICE ENGINEER
STATE HIGHWAY COMMISSION
HELENA, MONTANA.

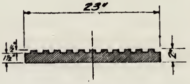
APPROVED Jan. 1, 1956
Scott P. Hart
STATE HIGHWAY ENGINEER

Montana State Highway Commission

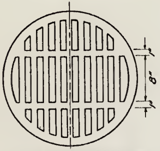
COMBINATION MANHOLE AND CATCH BASIN



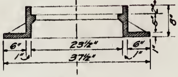
DETAIL
CATCH BASIN COVER



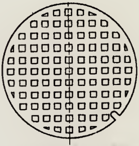
DETAIL
MANHOLE COVER



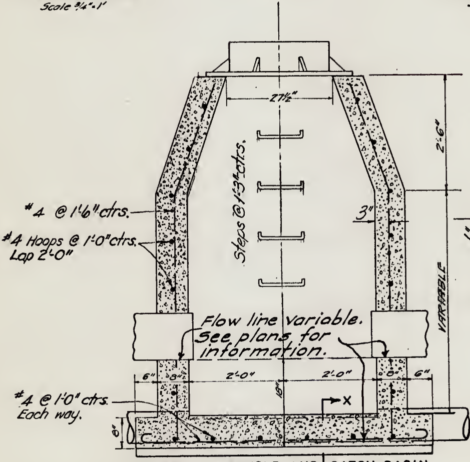
CATCH BASIN COVER
Scale ¾"-1'

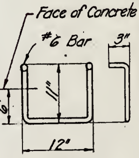


DETAIL
CASTING

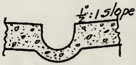


MANHOLE COVER
Scale ¾"-1'


27½"
2'-6"
Steps @ 1'-3" ctrs.
#4 @ 1'-6" ctrs.
#4 Hoops @ 1'-0" ctrs. Lap 2'-0"
3"
VARIABLE
Flow line variable. See plans for information.
6"
8"
2'-0"
2'-0"
8"
6"
18"
#4 @ 1'-0" ctrs. Each way.
8"
X



DETAIL OF STEP
Scale: ¾" = 1'-0"



SEC. X-X.

COMBINATION MANHOLE AND CATCH BASIN
Scale ½"=1'

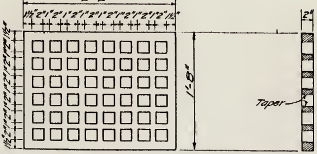
*Note: Walls of manhole or catch basin may be of concrete or cement blocks
These details to serve as an example. Designers will design to specific conditions
Use local standards where available.
All concrete to be Class "AD"*

APPROVED Jan. 1, 1936
Scott P. Hart
STATE HIGHWAY ENGINEER

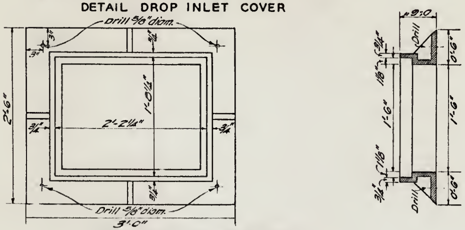
Montana State Highway Commission.

REV. 10-1-51

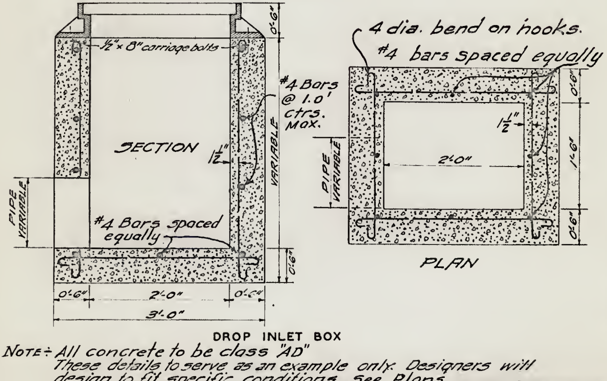
STANDARD DROP INLET



DETAIL DROP INLET COVER



DETAIL DROP INLET FRAME



DROP INLET BOX

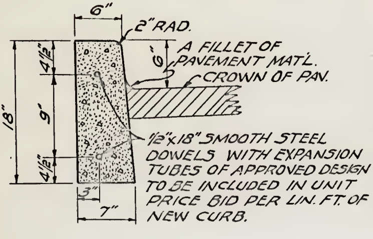
NOTE÷ All concrete to be class "AD"
These details to serve as an example only. Designers will design to fit specific conditions. See Plans for details & quantities.
Use local standards where available.

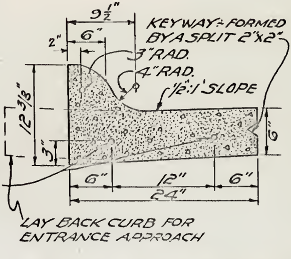
Montana State Highway Commission.

APPROVED Jan. 11 1956
Scott P. Hart
STATE HIGHWAY ENGINEER

REV. 10-1-51

STANDARD CONCRETE CURBS


6"
2" RAD.
A FILLET OF PAVEMENT MAT'L.
6"
CROWN OF PAV.
18"
4½"
9"
4½"
½"x18" SMOOTH STEEL DOWELS WITH EXPANSION TUBES OF APPROVED DESIGN TO BE INCLUDED IN UNIT PRICE BID PER LIN. FT. OF NEW CURB.
3"
7"


9½"
6"
2"
KEYWAY:- FORMED BY A SPLIT 2"x2"
3" RAD.
4" RAD.
½:1 SLOPE
12 3/8"
3"
6"
6"
12"
6"
24"
LAY BACK CURB FOR ENTRANCE APPROACH

SEPARATE CURB
0.031 C.Y. CONC. PER 1.0'

INTEGRAL CURB & GUTTER
0.048 C.Y. CONC. PER 1.0'

NOTE:- Quantities shown above are for estimating purposes only.
The above details to serve as an example only. Designers will design to fit specific conditions. See plans for details & quantities. Use local standards where available.

NOTES.

JOINTS: (a) When definitely tied to pavement slab. Separate curb or integral curb & gutter shall have the expansion joint of the pavement slab extended through & shall be completely filled with a minimum of of ½" width of preformed expansion joint filler with dowel bars fitted with expansion tubes at each joint.

(b) When not definitely tied to pavement slab. Separate curb or integral curb & gutter shall have through joints at predetermined intervals filled with a min. of ½" width of preformed expansion joint filler & with dowel bars fitted with expansion tubes. Such joint intervals shall be determined by prorating the distance between curb returns with such intervals to be not less than 30' nor greater than 50'. Dowel bars with expansion tubes & a min. of ½" width of preformed expansion joint filler shall be placed at the termini of all curb returns except that only dowel expansion tubes shall be placed in the end of the curb return when the curb return is not abutting old curb.

(c) A min. ½" width of preformed expansion joint filler shall be placed between the curb or gutter & the pavement slab in the case of Portland cement concrete.

(d) A min. ½" width of preformed expansion joint filler shall be placed between the curb & sidewalk or any solid structure.

(e) Preformed expansion joint filler shall comply with the requirements set forth in A.A.S.H.O. std. specs. Designation M-33 or M-153.

RADII: Minimum curb return radii - 10'.
15' radii desirable for streets & alleys.

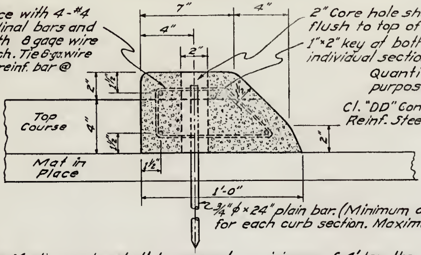
CONCRETE: Unless otherwise specified, conc. curbs & conc. integral curb & gutter shall be constructed of air-entrained class "AD" concrete.

Montana State Hwy. Comm.

APPROVED Jan. 1, 1956
STATE HIGHWAY ENGINEER

MEDIAN CONCRETE CURBS

TYPE "A" (MAT IN PLACE)



Reinforce with 4-#4 longitudinal bars and wrap with 8 gage wire @ 4½" pitch. Tie 8-ga. wire to every reinf. bar @ 2' ctrs.

2" Core hole shall be grouted flush to top of curb.

1"×2" key at both ends of each individual section for drainage.

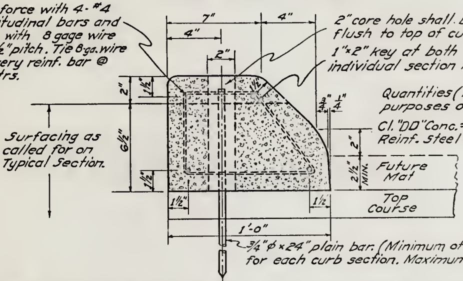
Quantities (For estimating purposes only)

Cl. "DD" Conc. = 0.015 Cu. Yd. per 1.0'
Reinf. Steel = 2.7 lbs. per 1.0'

¾" φ × 24" plain bar. (Minimum of two to be used for each curb section. Maximum spacing 6.0')

NOTES:-Median curbs shall be precast a minimum of 4' lengths & a maximum of 10' lengths. Class "DD" concrete shall be used throughout. All exposed edges shall be rounded ¾" radius.

TYPE "B" (FUTURE MAT)



Reinforce with 4-#4 longitudinal bars and wrap with 8 gage wire @ 4½" pitch. Tie 8-ga. wire to every reinf. bar @ 2' ctrs.

2" core hole shall be grouted flush to top of curb.

1"×2" key at both ends of each individual section for drainage.

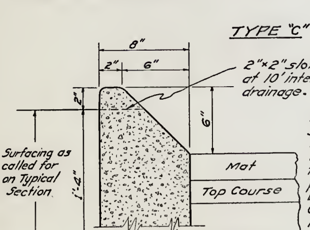
Quantities (For estimating purposes only.)

Cl. "DD" Conc. = 0.023 Cu. Yd. per 1.0'
Reinf. Steel = 2.7 lbs. per 1.0'

¾" φ × 24" plain bar. (Minimum of two to be used for each curb section. Maximum spacing 6.0')

NOTES:- Median curbs shall be precast a minimum of 4' lengths & a maximum of 10' lengths. Class "DD" concrete shall be used throughout. All exposed edges shall be rounded ¾" radius.

TYPE "C"



2"×2" slots in curb at 10' intervals for drainage.

Quantities (For estimating purposes only.)

Cl. "DD" Conc. = 0.032 Cu. Yd. per 1.0'

NOTES:-Excavation taken out of curb trench & sand used for leveling course to be included in unit price bid per lin. ft. of median curb. Median curbs shall be precast a minimum of 6' lengths for straight curbs & 4' lengths for curved portions. ½" premolded expansion joints shall be used at a maximum of 50' intervals. Class "DD" concrete shall be used throughout. All exposed edges shall be rounded ½" radius.

Montana State Highway Commission

APPROVED
Scott P. Hart
STATE HWY. ENGINEER
REV. 7-3-56
1-1-56

MONTANA STATE HIGHWAY COMMISSION

APPLICATION OF THE CLASSIFICATIONS AND GROUP INDEX OF SUBGRADE SOILS IN ESTIMATING DESIRABLE SUBBASE AND TOTAL PAVEMENT THICKNESS.

Reference: Data Taken from "Classification Of Soils And Subgrade Materials For Highway Construction Purposes" Adopted By Highway Research Board - 1945 (See Vol. 25). Revised December 15, 1955.

CONVERSION EQUIVALENTS INCHES TO FEET
1 in = 0.10 Ft
2 in = 0.15 Ft
2½ in = 0.20 Ft
3 in = 0.25 Ft
4 in = 0.35 Ft
5 in = 0.40 Ft
6 in = 0.50 Ft
7 in = 0.60 Ft
8 in = 0.70 Ft
9 in = 0.75 Ft
10 in = 0.85 Ft
11 in = 0.90 Ft
12 in = 1.00 Ft

GROUP INDEX OF SUBGRADE	THICKNESS IN FEET																							
	TRAFFIC VOLUME																							
	Less Than 100 Vehicles Per Day				100 to 300 Vehicles Per Day								More Than 300 Vehicles Per Day								Special Design Only			
					DRY AREAS				WET AREAS				DRY AREAS				WET AREAS							
		Combination Of Surface, Base & Sel. Mt'l Subbase Courses				Combination Of Surface, Base & Sel. Mt'l Subbase Courses				Combination Of Surface, Base & Sel. Mt'l Subbase Courses				Combination Of Surface, Base & Sel. Mt'l Subbase Courses				Combination Of Surface, Base & Sel. Mt'l Subbase Courses				Combination Of Surface, Base & Sel. Mt'l Subbase Courses		
	SURFACE & BASE COURSES ONLY	SURF & BASE	SEL. MAT'L SUBBASE	TOTAL	SURFACE & BASE COURSES ONLY	SURF & BASE	SEL. MAT'L SUBBASE	TOTAL	SURFACE & BASE COURSES ONLY	SURF & BASE	SEL. MAT'L SUBBASE	TOTAL	SURFACE & BASE COURSES ONLY	SURF & BASE	SEL. MAT'L SUBBASE	TOTAL	SURFACE & BASE COURSES ONLY	SURF & BASE	SEL. MAT'L SUBBASE	TOTAL	SURFACE & BASE COURSES ONLY	SURF & BASE	SEL. MAT'L SUBBASE	TOTAL
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Excellent A-1-a	0.15	0.15	0.00	0.15	0.40	0.40	0.00	0.40	0.50	0.50	0.00	0.50	0.60	0.60	0.00	0.60	0.70	0.70	0.00	0.70	0.70	0.70	0.00	0.70
Good 0 to 1	0.50	0.50	0.00	0.50	0.75	0.75	0.00	0.75	0.90	0.90	0.00	0.90	1.00	1.00	0.00	1.00	1.00	1.00	0.00	1.00	1.00	1.00	0.00	1.00
2	0.60	0.50	0.20	0.70	0.85	0.75	0.15	0.90	1.00	0.90	0.15	1.10	1.10	1.00	0.15	1.15	1.20	1.20	0.20	1.40	1.30	1.30	0.30	1.60
3	0.60	0.50	0.25	0.75	0.85	0.75	0.25	1.00	1.00	0.90	0.25	1.15	1.10	1.00	0.25	1.25	1.30	1.20	0.35	1.55	1.50	1.30	0.40	1.70
4	0.70	0.50	0.35	0.85	0.90	0.75	0.35	1.10	1.10	0.90	0.35	1.25	1.15	1.00	0.35	1.35	1.40	1.20	0.40	1.60	1.60	1.30	0.50	1.80
5	0.70	0.50	0.40	0.90	0.90	0.75	0.40	1.15	1 10	0.90	0.40	1.30	1.15	1.00	0.40	1.40	1.40	1.20	0.50	1.70	1.60	1.30	0.60	1.90
6	0.75	0.50	0.50	1.00	1.00	0.75	0.50	1.25	1.15	0.90	0.50	1.40	1.25	1.00	0.50	1.50	1.50	1.20	0.60	1.80	1.70	1.30	0.70	2.00
7	0.75	0.50	0.50	1.00	1.00	0.75	0.50	1.25	1.15	0.90	0.50	1.40	1.25	1.00	0.50	1.50	1.50	1.20	0.60	1.80	1.70	1.30	0.70	2.00
8	0.75	0.50	0.60	1.10	1.00	0.75	0.60	1.35	1.15	0.90	0.60	1.50	1.25	1.00	0.60	1.60	1.50	1.20	0.70	1.90	1.70	1.30	0.80	2.10
9	0.85	0.50	0.70	1.15	1.10	0.75	0.70	1.45	1.25	0.90	0.70	1.60	1.35	1.00	0.70	1.70	1.60	1.20	0.85	2.05	1.80	1.30	0.90	2.20
10	0.85	0.50	0.75	1.25	1.10	0.75	0.75	1.50	1.25	0.90	0.75	1.65	1.35	1.00	0.75	1.75	1.60	1.20	0.90	2.10	1.80	1.30	1.00	2.30
11	0.85	0.50	0.75	1.25	1.10	0.75	0.75	1.50	1.25	0.90	0.75	1.65	1.35	1.00	0.75	1.75	1.60	1.20	0.90	2.10	1.80	1.30	1.00	2.30
12	0.90	0.50	0.85	1.35	1.15	0.75	0.85	1.60	1.35	0.90	0.85	1.75	1.40	1.00	0.85	1.85	1.70	1.20	1.00	2.20	1.90	1.30	1.10	2.40
13	0.90	0.50	0.85	1.35	1.15	0.75	0.85	1.60	1.35	0.90	0.85	1.75	1.40	1.00	0.85	1.85	1.70	1.20	1.00	2.20	1.90	1.30	1.10	2.40
14	0.90	0.50	0.85	1.35	1.15	0.75	0.85	1.60	1.35	0.90	0.85	1.75	1.40	1.00	0.85	1.85	1.70	1.20	1.00	2.20	1.90	1.30	1.10	2.40
15	0.90	0.50	0.90	1.40	1.15	0.75	0.90	1.65	1.35	0.90	0.90	1.80	1.40	1.00	0.90	1.90	1.70	1.20	1.10	2.30	1.90	1.30	1.20	2.50
16	0.90	0.50	0.90	1.40	1.15	0.75	0.90	1.65	1.35	0.90	0.90	1.80	1.40	1.00	0.90	1.90	1.70	1.20	1.10	2.30	1.90	1.30	1.20	2.50
17	1.00	0.50	0.90	1.40	1.25	0.75	0.90	1.65	1.40	0.90	0.90	1.80	1.50	1.00	0.90	1.90	1.80	1.20	1.10	2.30	2.00	1.30	1.20	2.50
18	1.00	0.50	1.00	1.50	1.25	0.75	1.00	1.75	1.40	0.90	1.00	1.90	1.50	1.00	1.00	2.00	1.80	1.20	1.20	2.40	2.00	1.30	1.30	2.60
19	1.00	0.50	1.00	1.50	1.25	0.75	1.00	1.75	1.40	0.90	1.00	1.90	1.50	1.00	1.00	2.00	1.80	1.20	1.20	2.40	2.00	1.30	1.30	2.60
20	1.00	0.50	1.00	1.50	1.25	0.75	1.00	1.75	1.40	0.90	1.00	1.90	1.50	1.00	1.00	2.00	1.80	1.20	1.20	2.40	2.00	1.30	1.30	2.60

APPROVED-DEC. 15, 1955

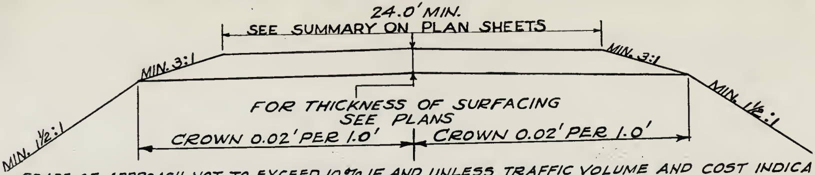
STATE HIGHWAY ENGINEER

NOTE:-Select Material Subbase As Listed On The Chart Is Identical With The Soil Listed In The Second Entry Of Column 1 Of The Chart As "Good, 0 To 1," And Is Defined Further As Material Which Includes The Common Run Of Fine Sands, Silty Sands, And Silty Or Clayey Gravels Which Have A Group Index Of Zero, With A Tolerance Of One Excepting The "Excellent A-1-a Material, These Materials Will Usually Fall In Groups A-1-b, A-3 And A-2, Although The Tolerance Of One Will Permit Inclusion Of Border Line Granular Materials Falling In Other Groups.

Use Column Listings Under "DRY AREAS" For High, Well Drained Bench Locations And Column Listings Under "WET AREAS" For Valley And Lowland Locations Shown In The Chart For Traffic Volumes Over 100 Vehicles Per Day.

Use A Minimum Of 1.0 Foot Of Select Material Subbase On All Embankment Soils Having Maximum Densities Of Less Than 90 Pounds Per Cubic Foot, Usually Glacial Tills In The A-4 Or A-5 Soils Classification.

SURFACING FOR BRIDGES & APPROACHES

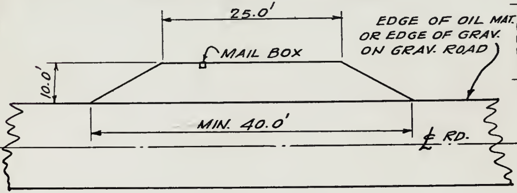


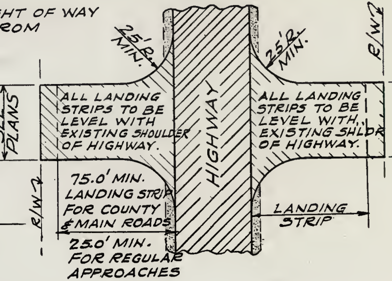
NOTE:- GRADE OF APPROACH NOT TO EXCEED 10% IF AND UNLESS TRAFFIC VOLUME AND COST INDICATE SUCH TO BE JUSTIFIABLE.

APPROACHES TO BE CONSTRUCTED TO FIT LOCAL CONDITIONS BUT CONSTRUCTED IN SUCH MANNER AS TO MINIMIZE TRAFFIC HAZARDS AND AFFORD SAFE AND COMMODIOUS ENTRY AND EXIT OF TRAFFIC TO AND FROM MAIN ROAD.

WHERE IT BECOMES NECESSARY TO GO BEYOND RIGHT OF WAY LINES, WRITTEN PERMISSION SHALL BE SECURED FROM PROPERTY OWNER IN ALL INSTANCES.

MAIL BOX TURNOUT

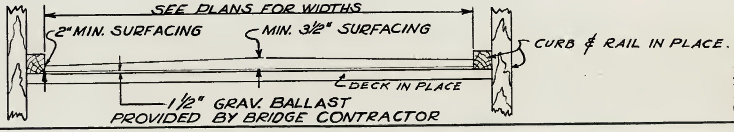




25' R. MIN.
25' R. MIN.
R/W
SEE PLANS
ALL LANDING STRIPS TO BE LEVEL WITH EXISTING SHOULDER OF HIGHWAY.
HIGHWAY
ALL LANDING STRIPS TO BE LEVEL WITH EXISTING SHLDR OF HIGHWAY.
SEE PLANS
R/W
75.0' MIN. LANDING STRIP FOR COUNTY & MAIN ROADS
25.0' MIN. FOR REGULAR APPROACHES
LANDING STRIP

SURFACE FOR BRIDGE

NOTE:- FOR ADDITIONAL INFORMATION & QUANTITIES SEE PLANS



MONTANA STATE HIGHWAY COMMISSION

REV. 7-20-56 REV. 10-1-51

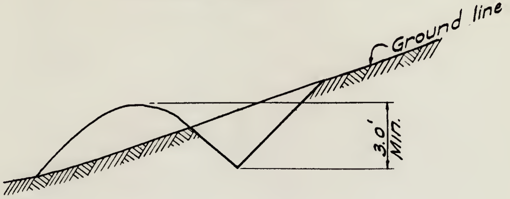
APPROVED 7-20-56

STATE HWY. ENGR.

141
RA1

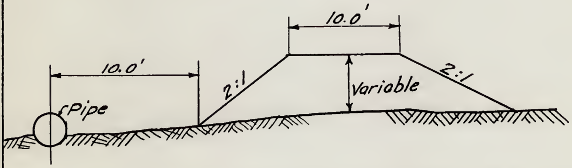
FURROW DITCH & DITCH BLOCK

FURROW DITCH



Exc. approx. 15 cu. Yds. per station.

DITCH BLOCK



Note:- keep top of ditch block at least 1.0 ft. below finished shoulder elevation and toe of slope flow 10.0' from pipe.

APPROVED Jan. 1, 1956
Scott P. Hart
STATE HIGHWAY ENGINEER

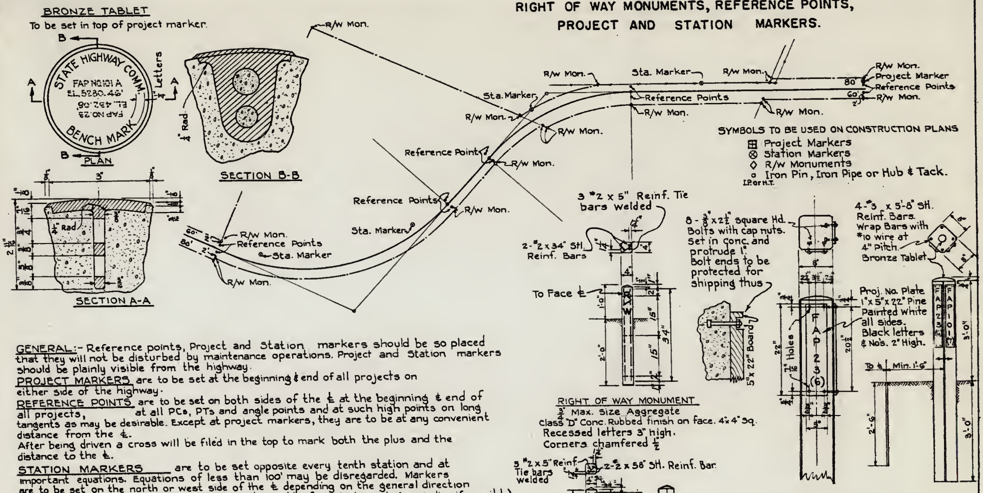
Montana State Highway Commission.

REV. 10-1-51

RIGHT OF WAY MONUMENTS, REFERENCE POINTS, PROJECT AND STATION MARKERS.

BRONZE TABLET

To be set in top of project marker.


STATE HIGHWAY COMM.
FAP No.101 A
EL. 5280.46'
FAP No. 23
EL. 432.08
BENCH MARK
Letters
A
B
PLAN
SECTION B-B
1/4" Rad.
3"
SECTION A-A
R/W Mon.
Sta. Marker
Reference Points
Reference Point
Project Marker
60'
80'
2'
SYMBOLS TO BE USED ON CONSTRUCTION PLANS
⊞ Project Markers
⊗ Station Markers
◇ R/W Monuments
○ Iron Pin, Iron Pipe or Hub & Tack.
I.P. or H.T.
3 #2 x 5" Reinf. Tie bars welded
2-#2 x 34" Stl. Reinf. Bars
To Face ℄
R/W
15"
34"
1'-0"
2'-0"
8 - 3/8" x 2 1/2" square Hd. Bolts with cap nuts. Set in conc. and protrude 1". Bolt ends to be protected for shipping thus
5" x 22" Board
Holes
F A P 23 (6)
Proj. No. Plate 1" x 5" x 22" Pine Painted white all sides. Black letters & Nos. 2" High.
4-#3 x 5'-8" Stl. Reinf. Bars. Wrap Bars with #10 wire at 4" Pitch.
Bronze Tablet
To ℄ Min. 1'-6"
3'-0"
2'-6"
3 #2 x 5" Reinf. Tie bars welded
2-#2 x 58" Stl. Reinf. Bar.
58"
13 1/2"
2'-6"

RIGHT OF WAY MONUMENT

3/4" Max. Size Aggregate

Class "D" Conc. Rubbed finish on face. 4"x4" Sq.

Recessed letters 3" high.

Corners chamfered 1/2"

STATION MARKERS

3/4" Max. Size Aggregate.

Class "D" Conc. Rubbed finish on face. 4" x 4" Sq.

Recessed letters 1 1/2" high. Corners chamfered 1/2".

PROJECT MARKER

Posts to be reinf. concrete. Aggregate 3/4 inch max. Class "D" Concrete. Corners chamfered 1/2". Project number Plate to be furnished & erected by State Forces. Series "D" letters & numerals to be used as per Std. alphabets published by Public Rds. Adm. 1945.

REFERENCE POINT

1" Iron pin. Another reference point to be set on opposite side of hwy.

GENERAL:- Reference points, Project and Station markers should be so placed that they will not be disturbed by maintenance operations. Project and Station markers should be plainly visible from the highway.

PROJECT MARKERS are to be set at the beginning & end of all projects on either side of the highway.

REFERENCE POINTS are to be set on both sides of the ℄ at the beginning & end of all projects, at all PCs, PTs and angle points and at such high points on long tangents as may be desirable. Except at project markers, they are to be at any convenient distance from the ℄.

After being driven a cross will be filed in the top to mark both the plus and the distance to the ℄.

STATION MARKERS are to be set opposite every tenth station and at important equations. Equations of less than 100' may be disregarded. Markers are to be set on the north or west side of the ℄ depending on the general direction of the route or shall be set so as to be visible from highway ℄. (on R/W line if possible)

RIGHT OF WAY MONUMENTS will be set at all points where the width of the R/W changes and at PCs, PTs and at angle points. When it seems undesirable to use the concrete monuments as on lot or block lines in some parts of a town, concrete monuments will be omitted & iron pipes or pins will be placed by State Highway Commission forces.

BRONZE TABLET. Exposed surfaces of the tablet are to be ground smooth. Letters are to be recessed 1/16 inch. Information on the tablet, indicated by pin lines, is to be stamped in the field by the engineering party after post is placed using 3/16" letters.

NOTE:- R/W monuments not to be ordered by contractor until checked in field by the Engineer.
R/W monuments to be placed so that outside face of monument coincides with R/W line as purchased.

Montana State Highway Commission

APPROVED Jan. 1, 1936
Scott P. Hart
STATE HIGHWAY ENGINEER

M1

REV. 2-15-55 REV. 6-1-48 REV. 10-1-51
REV. 1-27-47

STANDARD SUMMARY NOTES

GRADES	For relation of profile grade to sub-grade see typical section.
EMBANKMENT	Quantities shown on plans include shrinkage, unless otherwise noted.
SHRINKAGE	See Std. 242-SF & 243-SF1
BORROW	Borrow pits or source of borrow shown on plans, or as designated by Engr.
OVERHAUL	Free haul limit is 1000' feet.
SURPLUS	Surplus or excess to be disposed of as shown on plans or Spec. Provisions.
WIDENING	See Std. 231-G5
SUPERELEVATION	See Std. 231-G5
PROJECTIONS	All projections to be checked in field with reference to the staked line.

APPROVED Jan. 1, 1956
Scott P. Hart
STATE HIGHWAY ENGINEER

Montana State Highway Commission.

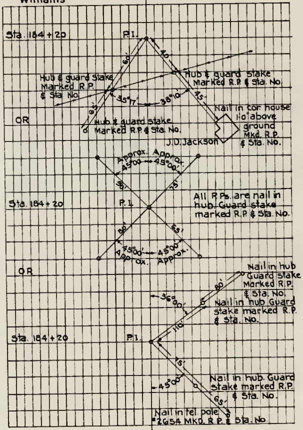
REV. 10-1-51
REV. 1-1-56

STANDARD LOCATION TRANSIT NOTES

Station	Point	Defl.	Δ	M.C.	C.C.
EQUATION				S.06°05'E.	S 26°00'E.
187+19.5	AHEAD				
= 185+20.5	P.T. BACK	10°05'			
185+00		9°34'			
184+20	P.I.		Δ=20°10' RT.		
			D=5°		
184+00		7°04'	T=203.8'		
			L=403.3'		
183+00		4°34'	R=1146.0'		
182+00		2°04'			
181+17.2	P.C.	0°00'			
				S46°10'E.	S26° 15'E.
				P.I. to P.I. 715.0'	
176+00	P.O.T.				

Johnson - Inst.
Rogers - Chain
Williams

6-16-21 16
Cloudy - Warm


Sta. 184+20
P.I.
60'
40'
Hub & guard Stake Marked R.P. & Sta. No.
Hub & guard Stake Marked R.P. & Sta. No.
35°17'
38°10'
45'
65'
OR
Hub & guard stake Marked R.P. & Sta. No.
Nail in cor. house 1-0" above ground Mkd. R.P. & Sta. No.
J.D. Jackson
Approx. 45°00'
Approx. 45°00'
90'
75'
Sta. 184+20
P.I.
All R.Ps. are nail in hub. Guard stake marked R.P. & Sta. No.
80'
65'
45°00' Approx.
45°00' Approx.
OR
Nail in hub Guard stake Marked R.P. & Sta. No.
80'
36°00'
Nail in hub Guard stake marked R.P. & Sta. No.
110'
Sta. 184+20
P.I.
15'
45°00'
Nail in hub. Guard stake marked R.P. & Sta. No.
65'
Nail in tel. pole #2654 MKD. R.P. & Sta. No

Reference Points at right angles if possible.

Reference Points must be firmly set and well marked so as to be easily found.

Run all curves from Harger and Bonney data.

Show detail data in proper column, how curve was staked in field.

Use sufficient space to make notes clear and distinct without crowding.

Curves may be located by deflection angles or tangent offsets.

When the deflection angle is 30° or greater the P.I. may be referenced by two R.Ps. on the back tangent produced ahead or the new tangent produced back. Measure distances to R.Ps

Show relationship between bearings of survey & bearings of adjoining projects.

Montana State Highway Commission

APPROVED Jan. 1, 1956
Geo. P. Hart
STATE HIGHWAY ENGINEER

REV. 1-1-56

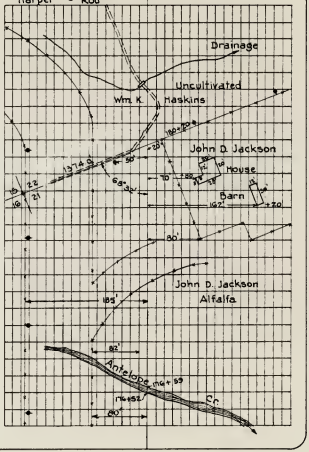
STANDARD TOPOGRAPHY NOTES

Station	Designation	Classification
182 + 00		
+ 10	36"x 28' C.M. Pipe (Poor) 2-M6 Hdwlls (Poor).	
181 + 00	Drain in place - Remove	
	New 48"x	
+ 40	Old road	
+ 20	Section line	
180 + 00		10% Rock
179 + 00		
178 + 00		
177 + 00		
+ 59	Top of bank	
+ 55	Creek bed	
+ 52	Top of bank	
176 + 00		

Johnson - Inst.
Rogers - Chain
Williams -
Harper - Rod

6-24-41
Cloudy - Warm

12



Where ties to section lines are made on a curve, same must be taken to semi-tangent and to circular curve.

Designate all structures, both in place and proposed. Irrigation or drainage. Show direction of flow.

For structures in place, be sure to give sizes, type & condition.

In land use, give cultivated, swamp or grazing.

Sketch all topography using direct & ties in feet. Pole lines to be identified as to kind, owner, & no. on poles, no. of wires & clearance. Wherever line crosses proposed center line. (Clearance is to the lowest wire). Station & Angle. On Power lines - give voltage.

On Bridge survey sheets fill in all requested data.

Classification can be covered by giving the percentage of rock.

Locate all springs.

__Do not crowd notes.__

Montana State Highway Commission.

APPROVED Jan. 1, 1956
Leo P. Hart
STATE HIGHWAY ENGINEER

REV. 1-30-52
REV. 1-1-56

APPROVED Jan. 4 1956
Fred P. Quinnell
STATE HIGHWAY ENGINEER

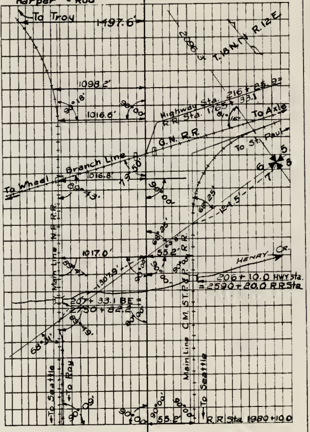
STANDARD TOPOGRAPHY NOTES (RAILROAD)

Station	Designation	Classification
224 + 00.0		
220+00.0		
218+090		
215+00.0		
214+67.3 = 2768+16.4 N.P. R.R. Sta = 1436+83.2 G.N.R.R. Sta.		
210+00.0 = 2763+49.1 R.R. Sta.		
C.M. St. P. & P.	75' Untr. Tbr. Pile Bridge On R.R.	Rt.
N.P. R.R.	66.3' Treated Tbr. Pile Bridge On R.R.	Lt.
205+00.0		
200+00.0	1017.9' Between ℄'s Highway & R.R.	Lt.

Johnson - Inst.
Rodgers - Chain
Williams -
Harper - Rod

6-24-41
Cloudy - Warm

13



Bridges on R.R. - Give length, water way area, type of bridge, Elevation top of rail, profile of stream or flow line from R.R. to Hwy. ℄, X-Sec. of that area.

Locate all R.R drainage structures, give sizes & Elev. of flow line.

Show all rivers, creeks & Irr. Dts.

Make at least two transit ties on each railway tangent on R.R. ℄ within 400' of any Hwy. ℄.

Make sufficient transit ties on curves so that the ℄'s can be accurately plotted.

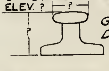
Give equivalent stationing of Hwy. to Ry. either by tying to a permanent Ry culvert, bridge or stationing marker; or by measuring distance along track from transit tie to permanent Ry. culvert or bridge.

At every location where Ry. & Hwy. are within 400' of each other, extend not less than two X-section from Hwy. ℄ across Ry. Emb.

When Hwy. is located along Ry. for considerable distance extend X-section across Ry. at Max. intervals of 500'.

Note the location of Ry. telephone or telegraph or power poles and number of wires, if between Hwy. and Ry., tie in with survey data.

Where Ry. crosses Hwy. show Hwy. Sta. & R.R. Sta., angle and on Ry. curve show chord Min. of 200' each side of center line.



Give Rail Dimensions.

STANDARD CROSS SECTION AND LEVEL NOTES

Station	+ B.S.	H.I.	− F.S.	Profile Rod Read.	Elev.	Jones - Inst. Harper - Rod	6-20-41 Clear - Warm	17
175 + 80		3642.54		0.67	3641.9'	Top S. rail - N.P. RY.		
176 + 00				3.6	38.9	2.5/30 3.2/15 3.6/0	3.8/30 2.2 N bk.Cr./140 5.6 W.S. 7.6 ℄ Ch/152 4.0 H.W./159 2.1 S.Bk.Cr./160	
+ 50				3.8	38.7	1.3/50 2.5/30 3.4/18 3.8/0	10.5/3 12.7/10 10.3/17 4.2/20 4.5/30	
+ 52				11.6	30.9	2.1/30 2.5/30 2.7/3 11.6/0	12.5/8 10.4/17 2.9/19 3.2/30	
Creek Fall + 57				11.6	30.9	9.6/300 10.9/200 11.2/100 11.4/50 11.4/25 11.5/15 11.6/0	11.7/30 11.8/50 11.9/100 12.3/200 13.2/300	
+ 59				11.5	31.0	2.8/50 3.2/30 3.5/18 11.5/15 12.3/7 11.5/0	9.3/3 8.6/6 4.0/30	
+ 60				2.9	39.6	2.2/50 2.5/30 8.7/26 11.7/20 9.5/3 2.9/0	3.3/30 4.0/60	
177 + 00				0.4	42.1	2.2 N Bk.Cr./100 4.0 H.W./97 5.6 ℄ Ch./95 4.5 W.S. 2.1 S.Bk.Cr./80 0.2/10 0.4/0	0.6/15 1.3/30 1.8/50	
B. M.	10.46	3652.83	0.20		3642.34	Hub & Guard 100' Rt. Sta. 177+00 (Elev. 3642.37)		
178 + 00				6.6	46.2	4.1/30 3.6/8 6.6/0	2.0/20 2.3/30	
179 + 00				6.4	46.4	5.5/20 6.4/4 6.4/0	2.0/20 2.3/30	
180 + 00				2.5	50.3	1.4/30 2.5/0	3.4/25 1.0/30	
+ 50				0.32	3652.5'	Top S rail N.P.RY.		

Note - Leave 3 to 4 Spaces betw. readings

Tie Bench levels into any adjoining projects.

Show Equa. in levels Beg. or End of project.

Take levels in creek beds sufficiently far from both sides of ℄ of creek to locate any proposed channel changes.

Take "base of rail" elevations every 500 ft. where ℄ parallels a railway. Extend X-sections to cover same.

Note all equations in column marked "Station" as shown in transit notes.

Give description of all B.M.'s. and location.

Take wide sections 200' or more when req'd. for high fills, deep cuts, channel changes, interception ditches, wide borrow pits, etc.

Note all flow line elevations - both stream and irrigation ditches. Note High water elev's. at critical points if possible.

Take Rod readings to nearest 0.1' with the exception of existing city pavements which should be taken to nearest 0.01'.

Cross section elevations when computed will be written immediately above rod reading as

$$\frac{39.3}{\frac{3.2}{15}}$$

Cross section to min. 100' Lt. & Rt. at all times.

Cross section to R.R. tracks when 150' or less.

Turn to B.M.'s at all times. Correct H.I.'s going ahead to original B.M. elevations unless there are obvious errors in the original bench levels.

Tie all B.M.'s to U.S.G.S. or U.S.C.& G.S. where possible.

Montana State Highway Commission.

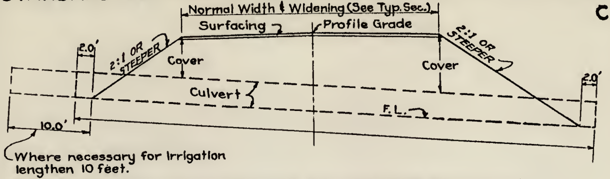
APPROVED Jan. 1, 1956
Scott P. Hart
STATE HIGHWAY ENGINEER

REV. 1-1-56

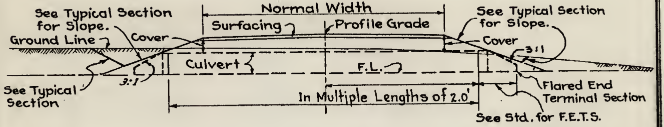
204
N3

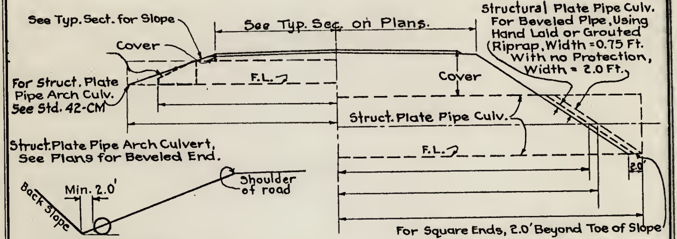
STANDARD METHOD OF DETERMINING CULVERT LENGTHS

C1


Normal Width & Widening (See Typ. Sec.)
Surfacing
Profile Grade
2.0'
2:1 OR STEEPER
Cover
2:1 OR STEEPER
Cover
2.0'
Culvert
F.L.
10.0'
Where necessary for irrigation lengthen 10 feet.

NOTE: Corrugated metal pipe (C.M.P.) is made in multiple lengths of 2'.
Concrete pipe is made in multiple lengths of 2.'


Normal Width
See Typical Section for Slope.
Surfacing
Profile Grade
See Typical Section for Slope.
Ground Line
Cover
Cover
3:1
Culvert
F.L.
3:1
See Typical Section
In Multiple Lengths of 2.0'
Flared End Terminal Section
See Std. for F.E.T.S.


See Typ. Sect. for Slope
See Typ. Sec. on Plans.
Structural Plate Pipe Culv. For Beveled Pipe, Using Hand Laid or Grouted Riprap, Width = 0.75 Ft. With no Protection, Width = 2.0 Ft.
Cover
F.L.
Cover
For Struct. Plate Pipe Arch Culv. See Std. 42-CM
Struct. Plate Pipe Culv.
Struct. Plate Pipe Arch Culvert, See Plans for Beveled End.
F.L.
2.0'
Back Slope
Min. 2.0'
Shoulder of road
For Square Ends, 2.0' Beyond Toe of Slope

APPROACH PIPE

F.L. = Flow line of culvert on ℄. (Note on cross-section.)
Draw in culvert outline solid at the proper cross-section station or nearest cross-section to it. Keep in mind that skewing the culvert will increase the length of culvert required. Place culvert low enough to drain borrow pits.

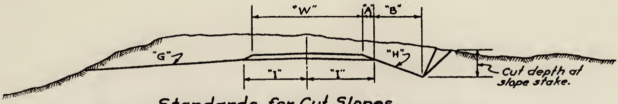
Irrigation pipe to be carried across borrow pits to a minimum of 10.0 feet bearing beyond edge of borrow. Channel changing irrigation ditch to obtain right angle crossing is prohibited unless specifically recommended.
Where fall of the ground permits proper drainage, pipe culverts are to be trenched into the natural ground to a depth of $\frac{1}{3}$ the diameter of the pipe.
Flared end terminal sections included in total Lin. Ft for pipe.
Spacing of multiple pipes..The adjacent sides shall be one-half dia. apart with 4 feet the maximum.

APPROVED Jan. 1, 1956
Scott P. Hart
STATE HIGHWAY ENGINEER

Montana State Highway Commission

REV. 1-1-56

TEMPLATING STANDARDS

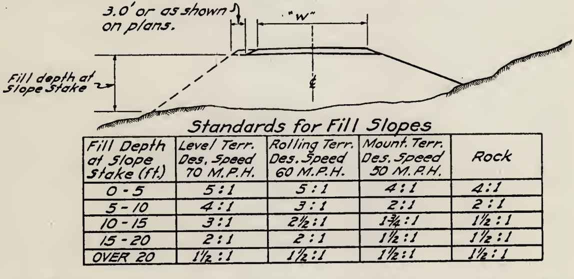


Standards for Cut Slopes

Cut Depth at Slope Stake (ft.)	Level Terr. Des. Speed 70 M.P.H.	Rolling Terr. Des. Speed 60 M.P.H.	Mount. Terr. Des. Speed 50 M.P.H.	Solid Rock
0 - 5	5:1	5:1	2:1	2:1
5 - 10	4:1	4:1	1½:1	1½:1
10 - 15	3:1	3:1	1½:1	½:1
15 - 20	2:1	2:1	1:1	½:1
OVER 20	1½:1	1½:1	1:1	½:1

"W"~ Normal width of roadway at finish grade.
"A"~ Distance for total surfacing.
"B"~ Standard width 15' minus "A".
"G"~ Daylight section should be carried on 10:1 grade from the bottom of the surfacing or top of sub-grade where possible.
"H"~ Inslope shall be 5:1.
"I"~ Use 0.02' per 1.0' for crown.

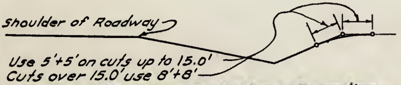
Backslopes to be uniform through each individual cut.



Standards for Fill Slopes

Fill Depth at Slope Stake (ft.)	Level Terr. Des. Speed 70 M.P.H.	Rolling Terr. Des. Speed 60 M.P.H.	Mount. Terr. Des. Speed 50 M.P.H.	Rock
0 - 5	5:1	5:1	4:1	4:1
5 - 10	4:1	3:1	2:1	2:1
10 - 15	3:1	2½:1	1¾:1	1½:1
15 - 20	2:1	2:1	1½:1	1½:1
OVER 20	1½:1	1½:1	1½:1	1½:1

Refer to Standards for widening and superelevation for curves.
NOTE:- The above information can be used for most designs, however, revisions can be made to fit specific conditions.



NOTE:- With the exception of rock material, all cut-slopes, 3:1 & steeper, to be rounded.

Section Showing Cut Slope Rounding

APPROVED Jan. 1, 1956
Scott P. Hart
STATE HIGHWAY ENGINEER

MONTANA STATE HIGHWAY COMMISSION

REV. 1-1-56

SOLAR OBSERVATION

DIRECT SOLAR OBSERVATION

OBSERVATION BY ______________ DATE __________

STATION ______________________________

LATITUDE ____________ N. LONGITUDE ____________ W.

WATCH READS ______________________ TIME

OBSRG. PROG.		WATCH TIME	VERTICAL ANGLE	HORIZONTAL ANGLE & DIRECT. TO SUN
TELS'PE	SUN			
1 DIR.	+			
6 REV.	+			
2 DIR.	+			
5 REV.	+			
3 DIR.	+			
4 REV.	+			
SUM				
MEAN				

REFRACTION & PARALLAX = ______

ADD

TRUE ALTITUDE(H) = ______ → LOG.SEC. = ______

LATITUDE = ______ → LOG.SEC. = ______

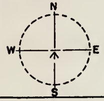
SUM(H + LAT.) = ______

NAT. SINE = ______ ← CO(90°-SUM) = ______

NAT. SINE = ______ ← DECLINATION = ______

ALG. SUM = ______ → → → LOG. OF ALG. SUM = ______

LOG. VERSINE AZ = ______



AZ. OF SUN(FROM S) = ______

HOR. ANGLE TO REF. PT. = ______

BEARING OF LINE = ______

NOTE:- ANY OTHER SUITABLE FORM MAY BE USED.

APPROVED Jan. 1, 1956
Scott P. Hart
STATE HIGHWAY ENGINEER

Montana State Highway Commission

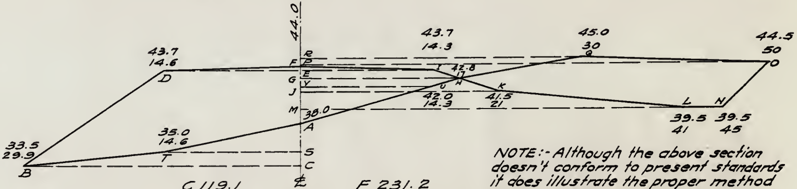
REV. 1-28-52

STANDARD FOR STAKING NOTES & COMPUTING END AREAS

A4

MONTANA STATE HIGHWAY COMMISSION

Sta.	Sub-Grade +	Hi.	Grade Rod	Super −	Elevation Shoulders Lt. Rt.	Rotchford – Inst. Iseminger – Rod Dorrington – Tape Jones – Axe				6/15/37 Clear-Warm				
B.M.	9.16	46.00			2036.84	Spike in 12" Tamarack 60' Lt. of Sta. 580+60								
						32.2	33.5	35.0	38.0	42.0	42.8	45.0	44.5	44.7
							-10.2	-8.7	-6.0	-1.7	-0.9		C5.0	C0.7
584	44.00		2.0		℄	13.8	12.5	11.0	8.0	4.0	3.2	1.0	1.5	1.3
			2.3 2.3		14.6 14.3	35	29.9	14.6		14.3	17	30	50	60
			4.5		21									
			6.5		41-45									



NOTE:- Although the above section doesn't conform to present standards it does illustrate the proper method of staking and computing end areas.

The starting point is determined as follows:-

A. Where the area crosses center-line, start with the lower of the two center-line points.

B. Where the area does not cross center line, start with the naught naught point closest to center line.

In going around the areas, proceed counter clockwise on the right of center-line & clockwise on the left.

This method deals entirely with triangles & trapezoids, the horizontal distances forming the bases & the vertical distances forming the altitudes. One side of each triangle or trapezoid is formed by a vertical distance (altitude) on center-line. The altitude is found by subtracting the elevations involved in going from one point to another. The horizontal distances are read direct, the altitude being multiplied by each of the two. In going from a higher point to a lower point the triangle or trapezoid is a minus quantity & vice versa the quantity is plus. When one of the two points is on center-line the figure is a triangle, otherwise it is a trapezoid. The formula for computing the area of any triangle or trapezoid is the altitude multiplied by the base or sum of the bases divided by two. This division is done last.

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STATE HIGHWAY ENGINEER

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REV. 1-1-56

CUT AREA

(42.8-41.5)x(17.0+21.0) = 1.3 x 38.0 = -49.40
area of trapezoid GJKH
(41.5-39.5)x(21.0+41.0) = 2.0 x 62.0 = -124.00
area of trapezoid JMLK
(44.5-39.5)x(45.0+50.0) = 5.0 x 95.0 = +475.00
area of trapezoid PMNO
(45.0-44.5)x(50.0+30.0) = 0.5 x 80.0 = +40.00
area of trapezoid RPOQ
(45.0-42.8)x(30.0+17.0) = 2.2 x 47.0 = -103.40
area of trapezoid RGHQ

Total Quantities	+515.00
Total Quantities	-276.80
	238 20

238.20 ÷ 2 = 119.10 square feet
Cut area of figure HKLNOQ

FILL AREA

(Left of center line).
(38.0-35.0)x(00.0+14.6) = 3.0 x 14.6 = -43.80
area of triangle AST
(35.0-33.5)x(14.6+29.9) = 1.5 x 44.5 = -66.75
area of trapezoid SCBT
(43.7-33.5)x(29.9+14.6) = 10.2 x 44.5 = +453.90
area of trapezoid ECBD
(44.0-43.7)x(14.6+00.0) = 0.3 x 14.6 = +4.38
area of triangle FED
(Right of center line).
(42.0-38.0)x(00.0+14.3) = 4.0 x 14.3 = +57.20
area of triangle VAU
(42.8-42.0)x(14.3+17.0) = 0.8 x 31.3 = +25.04
area of trapezoid GVUH
(43.7-42.8)x(17.0+14.3) = 0.9 x 31.3 = +28.17
area of trapezoid EGHI
(44.0-43.7)x(14.3+00.0) = 0.3 x 14.3 = +4.29
area of triangle FEI

Total Quantities	+572.98
Total Quantities	-110.55
	462.43

462.43 ÷ 2 = 231.215 square feet
Fill area of figure ATBDFIHU

CALCULATOR MACHINE METHOD COMPUTED WITH AN EIGHT ROW KEYBOARD

(All dials and the rows on the keyboard are numbered from the right to the left)

Turn into the upper dials 3 to 1 the elevation of the starting point as previously determined. In computing the area of the fill (ATBDFIHU) this figure would be 38.0. Establish two decimal points on the keyboard for the distances. In this instance the decimal points would be between rows 2 and 1 and between rows 7 and 6. Then the decimal points on the lower dials would be between dials 3 and 2 and between dials 8 and 7. The fill area either left or right of center-line can now be computed.

1. Starting on the left and proceeding clockwise, set the distance 14.6 around one of the keyboard decimals, say the one on the left side of the machine. Keyboard reads 14.60000.0. Change upper dials to read 35.0, the elevation at 14.6. Lower dials read (dials 11 to 1) 9956.20000.00 and the area of the triangle AST has been subtracted, always bearing in mind the fact that the final answer will be divided by 2.

2. Set 29.9 around the decimal point established on the right of the keyboard. Keyboard reads 14.60029.9. Change upper dials to read 33.5, the elevation at 29.9. Lower dials read (dials 11 to 1)

APPROVED Jan. 6 1956
STATE HIGHWAY ENGINEER

9934.29955.15 and the area of the trapezoid SCBT has been subtracted.

3. The next clockwise point is at 14.6 which is the number on the left of the machine. Therefore there is no change in the keyboard and it still reads 14.60029.9. Change upper dials to read 43.7, the elevation at 14.6 on the typical section or templet. Lower dials read (dials 10 to 1) 083.22260.13 and the area of the trapezoid ECBD has been added. It may be that a 1 or a 9 will appear in lower dial 12 or 13, depending upon the type of machine used or the manner in which the elevation 33.5 is changed to 43.7, but in any event disregard it.

Note: It is now obvious that the distances placed on the keyboard alternate from the left to the right of the keyboard, and that every distance is multiplied by the difference in elevation involved in going from one point to another. Therefore each distance is always multiplied by two figures, one when going to the distance and one when leaving the distance.

4. The next point is at center-line. Therefore clear the right side of the keyboard. Keyboard reads 14.60000.0. Change upper dials to read 44.0, the elevation at 0.0. Lower dials read (dials 10 to 1) 087.60260.13 and the triangle FED has been added.

5. Clear the left side of the keyboard. Keyboard reads 00.00000.0. Change upper dials to read 38.0. Lower dials will not change and the area to the right of center-line can now be computed.

6. Proceeding counter clockwise, set 14.3 on the left side of the keyboard. Keyboard reads 14.30000.0. Change upper dials to 42.0. Lower dials read 144.80260.13 and the triangle VAU has been added.

7. Set 17.0 on the right side of the keyboard. Keyboard reads 14.30017.0. Change upper dials to read 42.8. Lower dials read 156.24273.73 and the trapezoid GVUH has been added.

8. The next counter-clockwise point is at 14.3, so the keyboard reading remains 14.30017.0. Change upper dials to 43.7, lower dials read 169.11289.03, and the trapezoid EGHI has been added.

9. Clear the right side of the keyboard. Keyboard reads 14.30000.0. Change upper dials to read 44.0. Lower dials read 173.40289.03 and triangle FEI has been added.

10. Clear the keyboard. Considering the figure in the lower dials, 173.40289.03, as two separate answers, 173.40 and 289.03, add the two together. The result is 462.43, which number divided by 2 gives the fill area 231.215 square feet, figure ATBDFIHU.

1. In computing the cut area, turn 42.8 into the upper dials and set 17.0, the starting point and 21.0, the next counter clockwise point, on the keyboard. Keyboard reads 21.00017.0. Change upper dials to 41.5. Lower dials read 99972.69977.90 and the trapezoid GJKH has been subtracted.

2. Set 41.0 on the right of the keyboard. Keyboard reads 21.00041.0. Change upper dials to 39.5. Lower dials read 99930.69895.90 and the trapezoid JMLK has been subtracted.

3. Set 45.0 on the left of the keyboard. Keyboard reads 45.00041.0. 45.0 is the same elevation (39.5) as 41.0 so the upper dials do not change and lower dials remain 99930.69895.90.

4. Set 50.0 on the right of the keyboard. Keyboard reads 45.00050.0. Change upper dials to 44.5. Lower dials read 155.70145.90 and the trapezoid PMNO has been added.

5. Set 30.0 on the left of the keyboard. Keyboard reads 30.00050.0. Change upper dials to 45.0. Lower dials read 170.70170.90 and the trapezoid RPOQ has been added.

APPROVED Jan. 1 1956
STATE HIGHWAY ENGINEER

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6. Set 17.0 on the right of the keyboard. Keyboard reads 30.00017.0. Change upper dials to 42.8. Lower dials read 104.70133.50 and the trapezoid RGHQ has been subtracted.

7. Clear the keyboard. Set 104.70 on the right side of the keyboard rows 5 to 1. Keyboard reads 000104.70. Add once with the carriage in the first position and subtract once with the carriage in the sixth position. Lower dials read (dials 5 to 1) 238.20. Divide mentally by 2 and the answer is 119.10, the cut area figure HKLNOQ.

GENERAL NOTES

There are several contingencies which should be considered when using the machine method, depending upon the type of machine, the number of rows on the keyboard, the farthest distance used, and the size of the areas. These contingencies may cause errors and so will be considered.

1. There are so many different types and makes of calculators being used that no attempt will be made to follow every step on each machine, but it is suggested that an operator, when following the examples, note the unnecessary numbers which appear to the left on the lower dial (step #3 computing the fill area and step #4 computing the cut area) so that error will not be made by incorporating such numbers in the final answers.

2. When using an eight row keyboard with distances not exceeding 99.9 feet, error may be made (if the final area is 500.00 or more square feet) by the area on the right of the lower dials running into the area on the left when the area on the right becomes too large. However an error of this kind will be at least 500.00 square feet in the final area and by observation can be seen when it appears on the machine. When using a ten row keyboard, the same thing may happen if the final area is more than 5000.00 square feet.

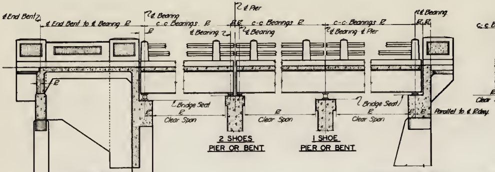
3. When the area is too large to work on your machine, split the area into enough parts so that it may be worked.

4. If the area extends past 100.0 feet, out from center-line, and there is therefore not enough rows on the keyboard (applicable to an eight row keyboard), subtract some constant from the distance on each rod reading and proceed as usual.

5. If on some area there is doubt, check it by longhand and the operator will soon become familiar with any machine errors.

6. If it is desired to figure exceedingly large areas (applicable particularly to overhaul) two machines may be used at the same time.

APPROVED Jan. 1, 1956
STATE HIGHWAY ENGINEER

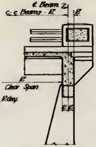


2 SHOES
PIER OR BENT

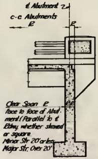
1 SHOE
PIER OR BENT

TOWER SPAN
SECTION ON ℄ RDWY.

CONCRETE END BENT
SECTION ON ℄ RDWY.

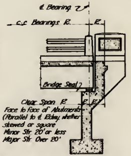


END BENT
SECTION ON ℄ RDWY.
(Conc. T-Beams Monolithic with Bent.)



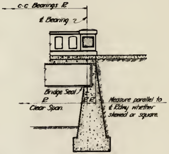
Clear Span ℞
Face to face of Abutment (Parallel to ℄ Rdwy whether skewed or square
Minor Str 20' or less
Major Str. Over 20'

CONCRETE ABUTMENT
SECTION ON ℄ RDWY.
Conc. T Beam Monolithic with Abut.
(Similar for Concrete Slab)

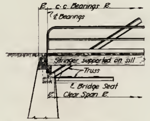


Clear Span ℞
Face to face of Abutments (Parallel to ℄ Rdwy whether skewed or square
Minor Str. 20' or less
Major Str. Over 20'

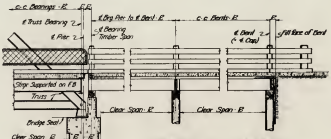
STEEL OR CONCRETE
GIRDER ON SHOE



GRAVITY ABUTMENT
WITH GIRDER SHOE



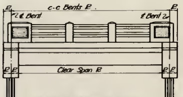
(OBSOLETE) TRUSS ON GRAVITY
ABUTMENT



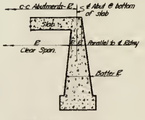
CONCRETE PIER

INTERMEDIATE PILE
BENT (SINGLE ROW)

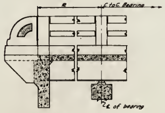
END PILE BENT
(SINGLE ROW)



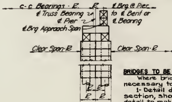
CONCRETE GIRDER SPAN WITH
CONCRETE PILES



SLAB MONOLITHIC WITH
GRAVITY ABUTMENT



CANTILEVER SPAN
SECTION ON ℄ RDWY.



PILE PIER

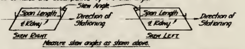
BRIDGES TO BE USED IN PLACE:—

Where bridges are to be used in place, it will be necessary to furnish the following data:

1- Detail drawing of structure, including cross section, showing all members in sufficient detail to make a complete H Rating analysis of the structure.
2- Stationing of ends of deck.
3- Stationing of centerline of bearing of all spans.
4- Centerline profile of groundline under structure.
5- Elevation of normal water and of highwater.
6- Roadway width between curbs.
7- Roadway width between rails.
8- Overall width-out to out of rail posts.

NOTES

All measurements shown on longitudinal sections marked "℞" shall be made in the field and shall be measured parallel to roadway; or if measured normal to piers and bents shall be so noted and accompanied by the skew angle.



Measure skew angles as shown above.

Measurements normal to ℄ Roadway shall consist of the following, Width of Roadway, at top of curbs (and at bottom), Center to center of rails; Out to out of curbs; Center to center of bearings.

Elevations shall be noted at the following points at each bent or pier; Roadway surface at ℄ of Roadway; Underside of superstructure, Bridge seat, Center of bearing pins, if used; and High Water elevation, Profile of stream and other topography required.

Measurements shall be accompanied by sketches in notebook indicating clearly the part measured and the direction, (skew).

In addition to measurements and sketches noted above, the following information shall be submitted—

BRIDGE OVER ____, PROJ. NO. __, FED. AID ROUTE NO. __________.
BRIDGE DESCRIPTION. __, STATION. ____, COUNTY ______, ERECTED (DATE).
FABRICATED BY _____, BUILT BY _______.

STATE MONTANA
STATE HIGHWAY COMMISSION

TIES FOR BRIDGE ENDS, PIERS AND BENTS

APPROVED JAN. 1, 1956
Scott P. Hart
STATE HIGHWAY ENGINEER

Revised ~ T.H.J. ~ 11-25-49
" IWH 5-4-53

DRAWING NO. Z-79

AREA OF CIRCULAR PIPES & PIPE ARCHES

CIRCULAR PIPE SIZE	PIPE ARCH SIZE	CROSS-SECT. AREA SQ. FT.
	18"×11"	1.1
	22"×13"	1.6
18"		1.8
	29"×18"	2.8
24"		3.1
	36"×22"	4.4
30"		4.9
	43"×27"	6.4
36"		7.1
	50"×31"	8.7
42"		9.6
	58"×36"	11.4
48"		12.6
	65"×40"	14.3
54"		15.9
	72"×44"	17.6
60"		19.6
72"		28.3
84"		38.5

APPROVED Jan. 1 1956
Scott P. Hart
STATE HIGHWAY ENGINEER

REV. 1-1-56

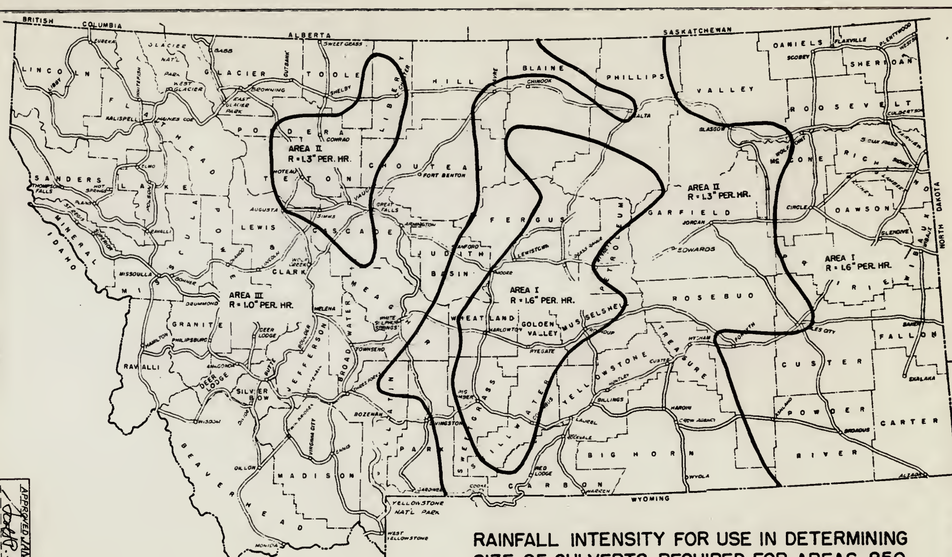
AREA OF STRUCTURAL PLATE PIPE & STRUCTURAL PLATE PIPE ARCH CULVERTS

S.P.P.C. SIZE	S.P.P.A.C. SIZE	CROSS-SECT. AREA SQ. FT.	S.P.P.C. SIZE	S.P.P.A.C. SIZE	CROSS-SECT. AREA SQ. FT.
60"		19.6		12'4"× 7'9"	74.0
	6'1"× 4'7"	22.0		12'6"× 7'11"	78.0
66"		23.8	120"		78.5
	6'4"× 4'9"	24.0		12'8"× 8'1"	81.0
	6'9"× 4'11"	26.0		12'10"× 8'4"	85.0
	7'0"× 5'1"	28.0	126"		86.6
72"		28.3		13'5"× 8'5"	89.0
	7'3"× 5'3"	31.0		13'11"× 8'7"	93.0
	7'8"× 5'5"	33.0	132"		95.0
78"		33.2		14'1"× 8'9"	97.0
	7'11"× 5'7"	35.0		14'3"× 8'11"	101.0
	8'2"× 5'9"	38.0	138"		103.9
84"		38.5		14'10"× 9'1"	105.0
	8'7"× 5'11"	40.0		15'4"× 9'3"	109.0
	8'10"× 6'1"	43.0		15'6"× 9'5"	113.0
90"		44.2	144"		113.1
	9'4"× 6'3"	46.0		15'8"× 9'7"	118.0
	9'6"× 6'5"	49.0		15'10"× 9'10"	122.0
96"		50.3	150"		122.7
	9'9"× 6'7"	52.0		16'5"× 9'11"	126.0
	10'3"× 6'9"	55.0		16'7"× 10'1"	131.0
102"		56.7	156"		132.7
	10'8"× 6'11"	58.0	162"		143.1
	10'11"× 7'1"	61.0	168"		153.9
108"		63.6	174"		165.1
	11'5"× 7'3"	64.0	180"		176.7
	11'7"× 7'5"	67.0			
114"		70.9			
	11'10"× 7'7"	71.0			

APPROVED Jan. 1, 1956
Scott P. Hart
STATE HIGHWAY ENGINEER

1-1-56

Montana State Highway Commission



MONTANA STATE HIGHWAY COMMISSION

RAINFALL INTENSITY FOR USE IN DETERMINING SIZE OF CULVERTS REQUIRED FOR AREAS 250 TO 10000 ACRES

APPROVED JAN. 1-1956

STATE HWY. ENGR.

REV. 1-1-56

INSTRUCTIONS FOR DETERMINING PIPE SIZES IN THE FIELD

A. Location Engineer will compute pipe size required, by use of tables on following pages and note the recommended size on the hardshell drawing. Items listed under "B" are also required.

Example

Given: Highway to cross 4 sq. mi. = 2560 acres drainage area (dry coulee) near Jordan. Land in the drainage basin is 80% grass pasture and 20% ploughed. Slope of principal channel is 10 feet per 1000 feet. Stream bed is clean and a fast runoff is indicated.

Jordan lies in Area II, for rainfall, on cover map (see STD. 224, C4.) Turn to Area II, Table, (see STD. 227, C7) and under Flat, 10'/1000', C = 0.30 (Area is mostly grass) and opposite the acreage of 2500 read Q = 246. sq. ft. Then one 78" C.M.P. is required.

B. ADDITIONAL FIELD DATA REQUIRED FOR DRAINAGE AREAS

The following factors should be investigated in the drainage basin and noted both in the field notes on drainage and on the hardshell drawing.

1. Area in acres (Use car mileage, maps or, stadia survey to obtain.)
2. Percentage of grass or grazing land, timber land and ploughed land. An estimate is sufficient.
3. Give general description of stream bed as to whether meandering, straight, brushy, clean, clay bottom, gravel bottom or containing large creek rock.
4. Check on existence of irrigation wasteways that may spill into the basin or other structures that may take out some of the water above.
5. Check whether any landowner above or below the proposed culvert is liable to suffer damage in flooding from backwater or from cutting of channel below.
6. Obtain slope for a portion of principal stream bed. Slope to be figured in feet per 1000 feet and be taken on a portion of channel considered as average for slope of entire channel.
7. Two cross sections of stream channel should be taken. One section should be taken near and above the creek crossing and at a point where a good high water mark exists as well as a narrowing down of the channel from a wider section above. The second section should be taken where a good high water mark can be found and at least 500 feet above the first section. The distance between sections should be measured along the stream meander. All elevations should be on the same datum as the road elevations. The distance from centerline of road at creek crossing to the first section should be measured along the stream.
8. Note the size of existing pipes or bridge openings and show the depth of high water for the upstream end.

AREA I

SIZE OF CULVERT REQUIRED FOR AREAS 250 TO 5000 ACRES

BASIS: BURKLI – ZIEGLER FORMULA

R = 1.6"/HR. RAINFALL   C = 0.25 FOR FARMING AREAS, CULTIVATED   C = 0.30 FOR GRASSED SLOPES, PASTURE LAND
LENGTH OF CULVERT ≧ 100' AND W.S. AT TOP EDGE AT INLET, FREE OUTLET.   MIN. SLOPE OF CULVERT = 1.0 %

AREA (IN ACRES)		VERY FLAT						FLAT				STEEP			
		1.0'/1000'		3.0'/1000'		5.0'/1000'		10'/1000'		20'/1000'		30'/1000'		40'/1000'	
		C=0.25	C=0.30	0.25	0.30	0.25	0.30	0.25	0.30	0.25	0.30	0.25	0.30	0.25	0.30
250	Q (C.F.S.)	25	30	34	41	38	46	46	55	54	65	60	72	64	77
	SIZE PIPE	30"	30"	36"	36"	36"	42"	42"	42"	42"	48"	42"	48"	48"	48"
500	Q	43	52	56	67	65	78	78	94	92	110	100	120	106	127
	P	36"	42"	42"	48"	48"	48"	48"	54"	54"	54"	54"	60"	54"	60"
750	Q	58	70	77	93	88	106	104	125	124	149	136	163	144	173
	P	42"	48"	48"	54"	54"	54"	54"	60"	60"	60"	60"	66"	60"	66"
1000	Q	72	87	96	115	108	130	127	152	152	183	168	202	180	216
	P	48"	48"	54"	54"	54"	60"	60"	60"	60"	66"	66"	72"	66"	72"
1250	Q	84	101	112	135	128	154	152	183	180	216	196	235	216	254
	P	48"	54"	54"	60"	60"	60"	60"	66"	66"	72	66"	72"	72"	78"
1500	Q	96	115	128	154	148	178	176	211	208	250	224	269	240	288
	P	54"	54"	60"	60"	60"	66"	66"	72	72"	78"	72"	78"	78"	78"
1750	Q	108	130	144	173	164	197	192	231	232	279	254	304	272	326
	P	54"	60"	60"	66"	66"	66"	66"	72"	72"	78"	78"	84"	78"	84"
2000	Q	120	144	160	192	179	215	213	256	256	307	280	336	296	355
	P	60"	60"	66"	66"	66"	72"	72"	78"	78"	84"	78"	84"	84"	90"
2250	Q	130	156	172	206	200	240	232	279	280	336	304	365	328	394
	P	60"	60"	66"	72"	72"	78"	72"	78"	78"	84"	84"	90"	84"	90"
2500	Q	140	168	188	226	212	254	252	303	300	360	332	398	356	426
	P	60"	66"	66"	72"	72"	78"	78"	84"	84"	90"	84"	90"	90"	96"
3000	Q	164	197	216	259	240	288	288	345	344	413	380	456	408	490
	P	66"	66"	72"	78"	78"	84"	84"	90"	90"	96"	90"	96"	90"	96"
3500	Q	180	216	240	288	272	327	328	394	386	463	424	508	458	549
	P	66"	72"	78"	78"	78"	84"	84"	90"	90"	96"	96"	102"	96"	108"
4000	Q	200	240	268	322	301	361	358	430	424	508	471	565	507	608
	P	72"	78"	78"	84"	84"	90"	90"	96"	96"	102"	96"	108"	102"	108"
4500	Q	220	264	290	348	329	395	392	471	465	558	515	617	555	666
	P	72"	78"	78"	90"	84"	90"	90"	96"	96"	108"	102"	108"	108"	108"
5000	Q	240	288	314	377	360	432	423	508	505	605	557	670	600	720
	P	78"	78"	84"	90"	90"	96"	96"	102"	102"	108"	108"	108"	108"	120"

NOTE: - For acreage greater than 5000, see Std. 229-C9.

MONTANA STATE HIGHWAY COMMISSION

APPROVED Jan. 1, 1956
Scott P. Hart
STATE HWY. ENGR.

226-C6

AREA II

SIZE OF CULVERT REQUIRED FOR AREAS 250 TO 5000 ACRES

BASIS: BURKLI - ZIEGLER FORMULA
R=1.3"/HR. RAINFALL   C=0.25 FOR FARMING AREAS, CULTIVATED   C=0.30 FOR GRASSED SLOPES, PASTURE LAND
LENGTH OF CULVERT ≅ 100' AND W.S. AT TOP EDGE AT INLET, FREE OUTLET.   MIN. SLOPE OF CULVERT = 1.0 %

AREA (IN ACRES)		VERY FLAT						FLAT				STEEP			
		1.0'/1000'		3.0'/1000'		5.0'/1000'		10'/1000'		20'/1000'		30'/1000'		40'/1000'	
		C=0.25	C=0.30	0.25	0.30	0.25	0.30	0.25	0.30	0.25	0.30	0.25	0.30	0.25	0.30
250	Q (C.F.S.) SIZE PIPE	20 30"	24 30"	28 30"	33 36"	30 36"	37 36"	37 36"	45 42"	44 42"	53 42"	49 42"	58 42"	52 42"	63 42"
500	Q P	35 36"	42 36"	46 42"	55 42"	53 42"	63 42"	63 42"	76 48"	75 48"	89 54"	81 48"	98 54"	86 48"	103 54"
750	Q P	47 42"	57 42"	63 48"	76 48"	72 48"	86 48"	85 48"	102 54"	101 54"	121 60"	110 54"	133 60"	117 60"	140 60"
1000	Q P	59 42"	71 48"	78 48"	93 54"	88 54"	106 54	103 54'	123 60"	123 60"	149 60"	136 60"	164 66"	146 60"	175 66"
1250	Q P	68 48"	82 48"	91 54"	110 54"	104 54"	125 60"	123 60"	149 60"	146 60"	175 66"	159 66"	191 66"	175 66"	206 72"
1500	Q P	78 48"	94 54"	104 54"	125 60"	120 60"	144 60"	143 60"	172 66"	169 66"	203 72"	182 66"	218 72"	195 72"	234 78"
1750	Q P	88 54"	106 54"	117 60"	140 60"	133 60"	160 66"	156 66"	188 66"	189 66"	227 72"	206 72"	247 78"	221 72"	265 78"
2000	Q P	98 54"	117 60"	130 60"	156 66"	145 60"	175 66"	173 66'	208 72"	208 72"	249 78"	228 72"	273 78"	240 78"	288 84"
2250	Q P	106 54"	127 60"	140 60"	167 66"	163 66"	195 72"	169 66"	226 72"	227 72"	273 78"	247 78"	296 84"	266 78"	320 84"
2500	Q P	114 54"	137 60"	153 60"	184 66"	172 66"	206 72"	205 72"	246 78"	244 78"	292 84"	270 78"	323 84"	289 84"	346 90"
3000	Q P	133 60"	160 66"	175 66"	210 72"	195 72"	234 72"	234 72"	280 78"	280 78"	336 90"	309 84"	371 90"	332 84"	398 90"
3500	Q P	146 60"	175 66"	195 72"	234 72"	221 72"	266 78"	266 78"	320 84"	314 84"	376 90"	344 90"	413 96"	372 90"	446 96"
4000	Q P	163 66"	195 72"	218 72"	262 78"	244 78"	294 84"	291 84"	350 90"	344 90"	413 96"	383 90"	459 96"	412 96"	494 102"
4500	Q P	179 66"	214 72"	236 78"	283 78"	268 78"	321 84"	318 84"	384 90"	378 90"	454 96"	419 96"	502 102"	451 96"	541 102"
5000	Q P	195 72"	234 72"	255 78"	306 84"	292 84"	351 90"	344 90"	413 96"	410 96"	492 102"	453 96"	545 108"	488 102"	585 108"

NOTE: - For acreage greater than 5000, See Std. 229 - C9.

MONTANA STATE HIGHWAY COMMISSION

APPROVED Jan. 4, 1956
STATE HWY. ENGR.

227-C7

AREA III

SIZE OF CULVERT REQUIRED FOR AREAS 250 TO 5000 ACRES

BASIS: BURKLI-ZIEGLER FORMULA

R=1.0"/HR. RAINFALL C=0.25 FOR FARMING AREAS, CULTIVATED C=0.30 FOR GRASSED SLOPES, PASTURE LAND
LENGTH OF CULVERT 100' AND W.S. AT TOP EDGE AT INLET, FREE OUTLET. MIN. SLOPE OF CULVERT= 1.0 %

AREA (IN ACRES)		VERY FLAT						FLAT				STEEP			
		1.0'/1000'		3.0'/1000'		5.0'/1000		10'/1000'		20'/1000'		30'/1000'		40'/1000'	
		C=0.25	C=0.30	0.25	0.30	0.25	0.30	0.25	0.30	0.25	0.30	0.25	0.30	0.25	0.30
250	Q (C.F.S.)	16	19	21	26	24	29	29	34	34	41	38	45	40	48
	SIZE PIPE	24"	24"	30"	30"	30"	30"	30"	36"	36"	36"	36"	42"	36"	42"
500	Q	27	33	35	42	41	49	49	59	58	69	63	75	66	79
	P	30"	36"	36"	36"	36"	42"	42"	42"	42"	48"	48"	48"	48"	48"
750	Q	36	44	48	58	55	66	65	78	77	93	85	102	90	108
	P	36"	36"	42"	42"	42"	48"	48"	48"	48"	54"	48"	54"	54"	54"
1000	Q	45	55	60	72	68	81	79	95	95	114	105	126	112	135
	P	42"	42"	42"	48"	48"	48"	48"	54"	54"	54"	54"	60"	54"	60"
1250	Q	53	63	70	84	80	96	95	114	113	135	122	147	135	159
	P	42"	42"	48"	48"	48"	54"	54"	54"	54"	60"	60"	60"	60"	66"
1500	Q	60	72	80	96	93	111	110	132	130	156	140	168	150	180
	P	42"	48"	48"	54"	54"	54"	54"	60"	60"	60"	60"	66"	60"	66"
1750	Q	68	81	90	108	102	123	120	144	145	174	159	190	170	204
	P	48"	48"	54"	54"	54"	60"	60"	60"	60"	66"	66"	66"	66"	72"
2000	Q	75	90	100	120	112	134	133	160	160	192	175	210	185	222
	P	48"	54"	54"	60"	54"	60"	60"	66"	66"	66"	66"	72"	66"	72"
2250	Q	81	97	107	129	125	150	145	175	175	210	190	228	205	246
	P	48"	54"	54"	60"	60"	60"	60"	66"	66"	72	66"	72"	72"	78"
2500	Q	88	105	117	141	133	159	157	189	188	225	208	249	222	266
	P	54"	54"	60"	60"	60"	66"	66"	66"	66"	72"	72"	78"	72"	78"
3000	Q	102	123	135	162	150	180	180	216	215	258	238	285	255	306
	P	54"	60"	60"	66"	60"	66"	66"	72"	72"	78"	78"	78"	78"	84"
3500	Q	112	135	150	180	170	204	205	246	241	290	265	317	286	343
	P	54"	60"	60"	66"	66"	72"	72"	78"	78"	84"	78"	84"	84"	90"
4000	Q	125	150	168	202	138	226	224	269	265	318	294	353	317	380
	P	60"	60"	66"	72"	66"	72"	72"	① 78"	78"	84"	84"	90"	84"	90"
4500	Q	138	165	181	218	206	247	245	295	291	349	322	386	347	416
	P	60"	66"	66"	72"	72"	78"	78"	① 84"	84"	90"	84"	90"	90"	96"
5000	Q	150	180	196	236	225	270	265	318	316	378	348	419	375	450
	P	60"	66"	66"	72"	72"	78"	78"	① 84"	84"	90"	90"	96"	90"	96"

NOTE:- For acreage greater than 5000, See Std. 229-C9.

MONTANA STATE HIGHWAY COMMISSION

APPROVED JAN. 1, 1956
STATE HWY. ENGR.

228-C8

SIZE OF CULVERT REQUIRED FOR AREAS 6000 TO 10,000 ACRES

BASIS: BURKLI-ZIEGLER FORMULA

C=0.25 FOR FARMING AREAS, CULTIVATED C=0.30 FOR GRASSED SLOPES, PASTURE

LENGTH OF CULVERT=100'– W.S. AT TOP EDGE AT INLET–FREE OUTLET–MIN. SLOPE OF CULVERT=1.0%

RAINFALL	AREA (IN ACRES)	Q=C.F.S. P=PIPE SIZE	VERY FLAT						FLAT				STEEP			
			1.0'/1000'		3.0'/1000'		5.0'/1000'		10'/1000'		20'/1000'		30'/1000'		40'/1000'	
			C=0.25	C=0.30	0.25	0.30	0.25	0.30	0.25	0.30	0.25	0.30	0.25	0.30	0.25	0.30
AREA I (R=1.6)	6000	Q P	273 78"	328 84"	359 90"	431 96"	408 96"	490 102"	485 102"	582 108"	577 108"	692 114"	638 108"	766 120"	686 114"	823 126"
	7000	Q P	306 84"	367 90"	403 90"	484 96"	458 96"	550 102"	544 102"	653 114"	653 114"	784 120"	717 114"	860 126"	770 120"	924 126"
	8000	Q P	338 84"	406 90"	445 96"	534 102"	506 102"	607 108"	602 108"	722 114"	715 114"	858 126"	792 120"	950 132"	850 126"	1020 132"
	9000	Q P	370 90"	444 96"	486 96"	583 108"	553 108"	664 114"	657 114"	788 120"	781 120"	937 132"	865 126"	1038 132"	930 132"	1116 138"
	10000⊛	Q P	400 90"	480 96"	526 102"	631 108"	598 108"	718 114"	711 114"	853 126"	846 126"	1015 132"	936 132"	1132 132"	1006 132"	1207 144"
AREA II (R=1.3)	6000	Q P	222 72	267 78"	292 84"	350 90"	332 84"	398 96"	394 90"	473 96"	468 96"	562 108"	518 102"	622 108"	557 108"	669 114"
	7000	Q P	249 78"	299 84"	327 84"	392 90"	372 90"	447 96"	442 96"	531 102"	530 102"	636 114"	582 108"	698 114"	626 108"	751 120"
	8000	Q P	275 78"	330 84"	362 90"	435 96"	411 96"	494 102"	489 102"	587 108"	582 108"	698 114"	644 114"	773 120"	690 114"	829 126"
	9000	Q P	300 84"	360 90"	395 90"	474 96	449 96"	539 102"	534 102"	640 114"	635 108"	763 120"	703 114"	845 126"	756 120"	907 126"
	10000⊛	Q P	325 84"	390 90"	427 96"	512 102"	486 102"	583 108"	578 108"	694 114"	688 114"	825 126"	760 120"	914 126"	817 126"	981 132"
AREA III (R=1.0)	6000	Q P	170 66"	205 72"	224 72"	269 78"	255 78"	306 84"	303 84"	364 90"	360 90"	432 96"	398 96"	478 102"	429 96"	514 102"
	7000	Q P	190 66"	230 72"	252 78"	302 84"	286 84"	344 90"	340 90"	408 96"	407 96"	489 102"	448 96"	538 102"	480 102"	578 108"
	8000	Q P	210 72"	253 78"	278 78"	334 84"	317 84"	380 90"	376 90"	452 96"	447 96"	537 102"	495 102"	594 108"	530 102"	638 114"
	9000	Q P	230 72"	277 78"	304 84"	365 90"	346 90"	415 96"	411 96"	494 102"	488 102"	586 108"	540 102"	648 114"	580 108"	698 114"
	10000⊛	Q P	250 78"	300 84"	329 84"	395 90"	374" 90"	449 96"	445 96"	535 102"	528 102"	635 108"	585 108"	703 114"	628 108"	754 120"

⊛ NOTE: IN ALL INSTANCES WHERE THE DRAINAGE AREA REPORTED BY THE LOCATION ENGINEER IS IN EXCESS OF 10,000 ACRES, THE SITUATION WILL BE STUDIED AND THE SIZE OF DRAINAGE OPENINGS DETERMINED BY THE HYDRAULIC ENGINEER OF THE PRECONSTRUCTION DIV. WORKING IN COLLABORATION WITH THE BRIDGE ENGINEER.

MONTANA STATE HIGHWAY COMMISSION

APPROVED 1-1-56

STATE HWY. ENG'R.

229-C9

TABLES FOR WIDENING & SUPERELEVATION

This table is based on the Formula:-

$$S + F = \frac{0.067\,V^2}{R}$$

S = Superelevation slope in feet per foot.
F = Side friction factor.
R = Radius of curve in feet.
V = Velocity in miles per hour.

A.A.S.H.O. has arrived at certain values of side friction factors which are considered safe for highway design. Considering 0.08 feet per foot as maximum superelevation, they are:

40 mph ~ 0.15
50 mph ~ 0.14
60 mph ~ 0.13
70 mph ~ 0.12

SUPERELEVATION (FEET PER FOOT)																	
Design Speed m.p.h.	0°15′	0°30′	0°45′	1°00′	1°30′	2°00′	2°30′	3°00′	3°30′	4°00′	5°00′	6°00′	7°00′	7°30′	8°00′	9°00′	10°00′ & UP
40	NC	NC	.02	.02	.02	.03	.03	.04	.04	.04	.05	.06	.07	.07	.07	.07	.08
50	NC	.02	.02	.02	.03	.04	.04	.05	.06	.06	.07	.08	.08	.08			
60	NC	.02	.02	.02	.04	.05	.06	.07	.07	.08	.08						
70	.02	.02	.02	.03	.04	.06	.07	.08	.08								

N.C. = Normal Crown.

If possible, the superelevation should be reduced from the full value at the P.C. or P.T. proportionally to normal crown through the following distances:-

Design Speed (m.p.h.)	Runoff Distance (Feet)
40	175
50	200
60	225
70	250

Minimum runoff 100.0′.

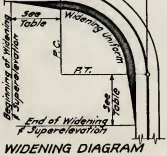
Superelevation shall be rotated about profile grade and elevations less normal crown carried on the inside shoulder.

Where property is closely built up in municipalities and elsewhere. and at intersections and where other special speed restrictions exist, the rate of superelevation is to be modified to conform to reasonable speed requirements.

WIDENING																								
Degree	3°	4°	5°	6°	7°	8°	9°	10°	11°	12°	13°	14°	15°	16°	17°	18°	19°	20°	21°	22°	23°	24°	25°	26° & UP
Widening	2′	2′	2′	2′	2′	2′	2′	2′	3′	3′	3′	3′	3′	3′	3′	3′	3′	4′	4′	4′	4′	4′	4′	5′

This table is based on the Formula:- $W = 2(R - \sqrt{R^2 - L^2}) + \frac{V}{\sqrt{R}}$

W = Total widening in feet.
R = Radius of the curve in feet.
L = Wheelbase of vehicle in feet. = (20 feet)
V = Speed.


℄
See Table
Widening Uniform
P.C.
P.T.
Beginning of Widening & Superelevation
See Table
End of Widening & Superelevation

WIDENING DIAGRAM

Where the distance from the P.T. to the next P.C. is less than 200′ and the curves are in the same direction, the widening shall be continuous between them. If the curves are in opposite directions widen for each as per diagram.

Formula for Superelevation:-

$$\text{Elevation} = 0.067 \times \frac{\text{Velocity}^2}{\text{Radius}}$$

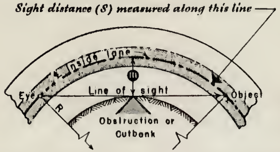
Formula for Widening:-

$$W = 2(R - \sqrt{R^2 - L^2}) + \frac{V}{\sqrt{R}}$$

R = Radius
L = Wheelbase = 20 ft.
V = Velocity = 40 m.p.h.

APPROVED Jan. 1, 1956
STATE HIGHWAY ENGINEER

NON-PASSING SIGHT DISTANCE ON HORIZONTAL CURVES



Height of eye-4.5 feet. . . .Height of object-0.33 feet.

At obstruction, Line of Sight is 2.5 feet above center of inside lane.

S = SIGHT DISTANCE IN FEET
R = RADIUS OF ℄ INSIDE LANE IN FEET
m = DISTANCE FROM ℄ INSIDE LANE IN FEET
V = DESIGN SPEED FOR S IN M.P.H.

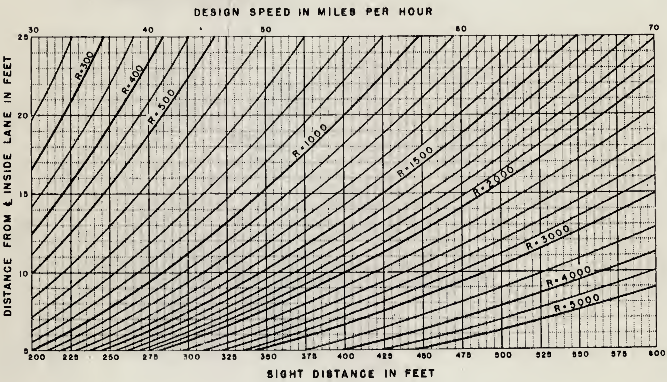
Angle is expressed in degrees.

$$m = R\left[\operatorname{vers}^{-1}\left(\frac{28.65S}{R}\right)\right]$$

$$S = \frac{R}{28.65}\left[\cos^{-1}\left(\frac{R-m}{R}\right)\right]$$

Formula applies only when S is equal to or less than length of curve.

DESIGN SPEED MPH	SIGHT DIST. FEET
40	275
50	350
60	475
70	600



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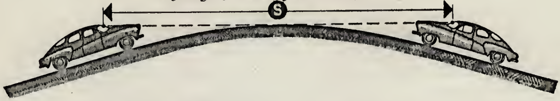
STATE HIGHWAY ENGINEER

PASSING SIGHT DISTANCE ON CREST VERTICAL CURVES

Height of eye is 4.5 feet above pavement



L = LENGTH OF VERTICAL CURVE IN STATIONS
A = ALGEBRAIC DIFFERENCE IN GRADE RATE IN %
S = SIGHT DISTANCE IN FEET
V = DESIGN SPEED IN M.P.H. FOR S

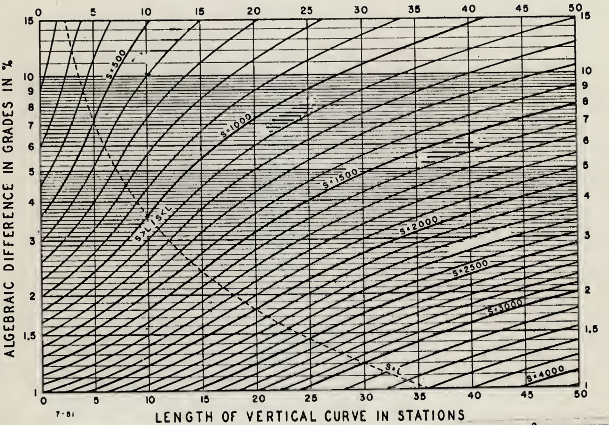
WHEN S > L

$$S = \frac{1800}{A} + 50L$$

WHEN S < L

$$S = 600\sqrt{\frac{L}{A}}$$

DESIGN SPEED MPH	SIGHT DIST. FEET
40	1300
50	1700
60	2000
70	2300



APPROVED Jan. 1, 1956
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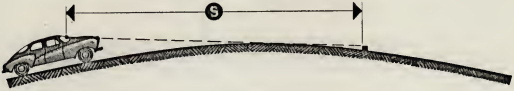
STATE HIGHWAY ENGINEER

1-1-56

Montana State Highway Commission

NON PASSING SIGHT DISTANCE ON CREST VERTICAL CURVES

Height of eye 4.5 feet
Height of object 0.33 feet



L = LENGTH OF VERTICAL CURVE IN STATIONS
A = ALGEBRAIC DIFFERENCE OF GRADES IN %
S = SIGHT DISTANCE IN FEET
V = DESIGN SPEED IN M.P.H. FOR S

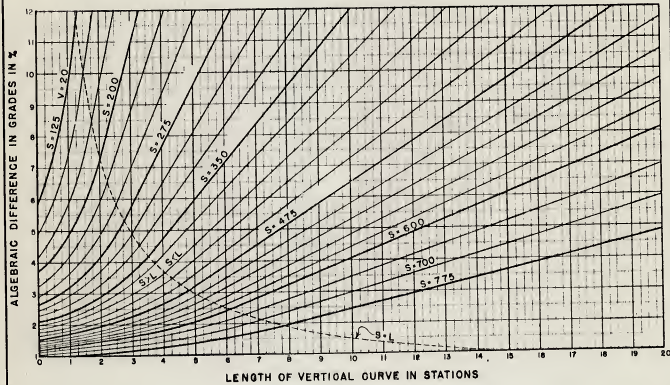
WHEN $S>L$

$$S=\frac{728}{A}+50L$$

WHEN $S<L$

$$S=382\sqrt{\frac{L}{A}}$$

DESIGN SPEED MPH	SIGHT DIST. FEET
40	275
50	350
60	475
70	600



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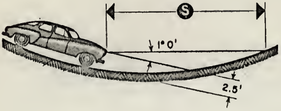
Montana State Highway Commission

1-1-56

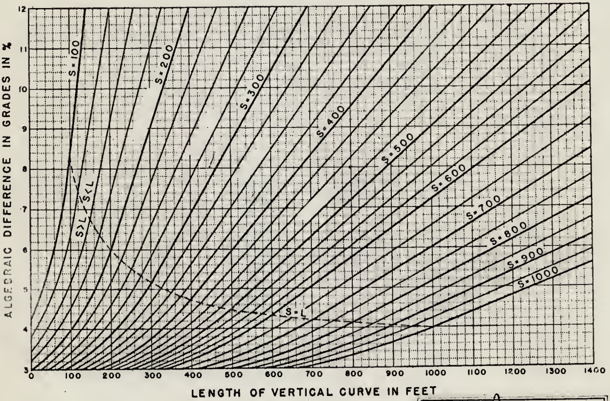
HEADLIGHT SIGHT DISTANCE ON SAG VERTICAL CURVES



DESIGN SPEED MPH	SIGHT DIST. FEET
40	275
50	350
60	475
70	600

L = LENGTH OF VERTICAL CURVE IN FEET
A = ALGEBRAIC DIFFERENCE OF GRADES
S = SIGHT DISTANCE IN FEET
V = DESIGN SPEED IN M.P.H. FOR S

WHEN S > L	WHEN S < L
$L=2S \quad \frac{5+0.035S}{A}$	$L=\frac{AS^2}{5+0.035S}$

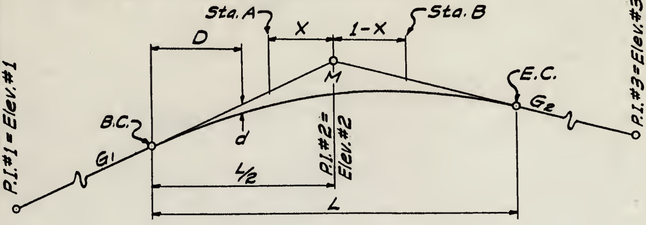


APPROVED Jan. 1, 1956
Scott P. Hart
STATE HIGHWAY ENGINEER

Montana State Highway Commission

1-1-56

COMPUTATION OF VERTICAL CURVES



Computing Intersections

Given- Grades G_1 & G_2, P.I.'s #1 & 3, Elev.'s #1 & 3.
Find- P.I. #2 & Elev. #2.

First, find elevations at Sta. A (the even station before P.I. #2) & Sta. B (the even station after P.I. #2).
Then, let X = distance from Sta. A to P.I. #2 in stations.
There fore, 1-X = distance from P.I. #2 to Sta. B in stations.

$$(\text{Elev. at Sta. }A)+G_1X=(\text{Elev. at Sta. }B)-G_2(1-X)$$

Note- Express grades G_1 & G_2 algebraically.

Computing Ordinates

$$M=\frac{(G_1-G_2)L}{8}$$

M = Middle Ordinate (ft.)
G_1 & G_2 = Rates of change (expressed algebraically)
L = Length of curve (stations)

$$d=D^2\frac{M}{(L/2)^2}$$

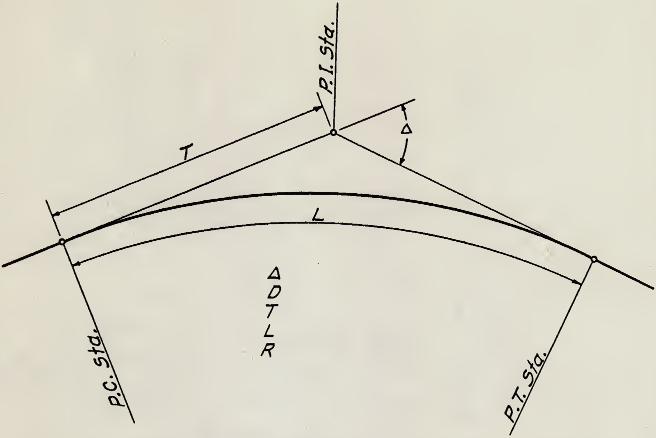
d = Correction from grade line to curve (ft.)
D = distance from B.C. or E.C. to any point on curve (ft)
L/2 = ½ the length of vertical curve (ft)

When computing a vertical curve on a slide rule,
1. Set runner to "M" on "A" scale.
2. Bring one half the length of curve on "C" scale to runner.
3. On "C" scale, set runner to any desired value of "D."
4. Read "d" for that "D" value on "A" scale.

APPROVED Jan. 1, 1956
Scott P. Hart
STATE HIGHWAY ENGINEER

1-1-56

COMPUTATION OF HORIZONTAL CURVES



Given ~ P.I. Sta., Δ (in degrees & minutes.), D (in degrees & minutes.)
Find ~ P.C. Sta., P.T. Sta., T, L & R.

$$T = \frac{T_1}{D}$$

$$L = \frac{100\Delta}{D}$$

$$R = \frac{5730.0}{D}$$

T = Tangent (ft.)
* T_1 = Tangent of 1° curve for Δ degrees (ft.)
⊕ D = Degrees of curvature expressed in degrees & decimals of degrees.
L = Length of curve (ft.)
⊕ Δ = Central angle expressed in degees & decimals of degrees.
R = Radius of curve (ft.)

P.I. Sta. − T = P.C. Sta. + L = P.T. Sta.

* - Use "Functions of a One Degree Curve" from "Highway Engineer's Handbook" by Harger & Bonney.
⊕ - To be carried four places past the decimal.

APPROVED Jan. 1, 1956
Scott P. Hart
STATE HIGHWAY ENGINEER
1-1-56

TABLE FOR COMPUTING YARDAGE

L=LENGTH K=CONSTANT S=SUM OF AREAS
FORMULA, SXK OPPOSITE L=C.U. YDS.

L	K	L	K	L	K	L	K	L	K
1	.01852	21	.38889	41	.75926	61	1.12963	81	1.50000
2	.03704	22	.40741	42	.77778	62	1.14815	82	1.51852
3	.05556	23	.42593	43	.79630	63	1.16667	83	1.53704
4	.07407	24	.44444	44	.81481	64	1.18519	84	1.55556
5	.09259	25	.46296	45	.83333	65	1.20370	85	1.57407
6	.11111	26	.48148	46	.85185	66	1.22222	86	1.59259
7	.12963	27	.50000	47	.87037	67	1.24074	87	1.61111
8	.14815	28	.51852	48	.88889	68	1.25926	88	1.62963
9	.16667	29	.53704	49	.90741	69	1.27778	89	1.64815
10	.18519	30	.55556	50	.92593	70	1.29630	90	1.66667
11	.20370	31	.57407	51	.94444	71	1.31481	91	1.68519
12	.22222	32	.59259	52	.96296	72	1.33333	92	1.70370
13	.24074	33	.61111	53	.98148	73	1.35185	93	1.72222
14	.25926	34	.62963	54	1.00000	74	1.37037	94	1.74074
15	.27778	35	.64815	55	1.01852	75	1.38889	95	1.75926
16	.29630	36	.66667	56	1.03704	76	1.40741	96	1.77778
17	.31481	37	.68519	57	1.05556	77	1.42593	97	1.79630
18	.33333	38	.70370	58	1.07407	78	1.44444	98	1.81481
19	.35185	39	.72222	59	1.09259	79	1.46296	99	1.83333
20	.37037	40	.74074	60	1.11111	80	1.48148	100	1.85185

MONTANA STATE HIGHWAY COMMISSION

REV. 1-1-56
REV. 10-1-51
REVISED-MARCH 26, 1946

APPROVED Jan. 1, 1956
STATE HIGHWAY ENGINEER

Y1

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Montana State Highway Commission

SHRINKAGE FACTORS
FOR ESTIMATING GRADING QUANTITIES
PER STATION UNCLASSIFIED
DOUBLE END AREA

%	DOUBLE END AREA
135	0 ——— 54
125	55 ——— 162
120	163 ——— 378
115	379 ——— 540
110	541 ——→

FOR SWELL ON ROCK - SEE RECOMMENDATIONS OF ENGINEER GEOLOGIST.

APPROVED Jan. 1 1956
STATE HIGHWAY ENGINEER

REV. 1-29-52
REV. 1-1-56

SHRINKAGE FACTORS
FOR ESTIMATING GRADING QUANTITIES
PER STATION
UNCLASSIFIED

Montana State Highway Commission.

CU. YDS.	TO	CU. YDS.	%
1		100	35 %
101		300	25 %
301		700	20 %
701		1000	15 %
1001 UP			10 %

FOR SWELL ON ROCK-SEE RECOMMENDATIONS OF ENGINEER GEOLOGIST.

APPROVED Jan. 1 1956
STATE HIGHWAY ENGINEER
REV. 10-1-51
REV. 1-1-56

LUMBER TABLE

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L

SIZE	LENGTH																	
	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40
2 x 4	4	5+	7-	8	9+	11-	12	13+	15-	16	17+	19-	20	21+	23-	24	25+	27-
2 x 6	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40
2 x 8	8	11-	13+	16	19-	21+	24	27-	29+	32	35-	37+	40	43-	45+	48	51-	53+
2 x 10	10	13+	17-	20	23+	27-	30	33+	37-	40	43+	47-	50	53+	57-	60	63+	67
2 x 12	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80
3 x 4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40
3 x 6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60
3 x 8	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	73
3 x 10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
3 x 12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	120
4 x 4	8	11-	13+	16	19-	21+	24	27-	29+	32	35-	37+	40	43-	45+	48	51-	53+
4 x 6	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80
4 x 8	16	21+	27-	32	37+	43-	48	53+	59-	64	69+	75-	80	85+	91-	96	101+	107-
4 x 10	20	27-	33+	40	47-	53+	60	67-	73+	80	87-	93+	100	107-	113+	120	127-	133+
4 x 12	24	32	40	48	56	64	72	80	88	96	104	112	120	128	136	144	152	160
6 x 6	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	120
6 x 8	24	32	40	48	56	64	72	80	88	96	104	112	120	128	136	144	152	160
6 x 10	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200
6 x 12	36	48	60	72	84	96	108	120	132	144	156	168	180	192	204	216	228	240
* 8 x 8	32	43-	53+	64	75-	85+	96	107-	117+	128	139-	149+	160	171-	181+	192	203-	213+
8 x 10	40	53+	67-	80	93+	107-	120	133+	147-	160	173+	187-	200	213+	227-	240	253+	267-
8 x 12	48	64	80	96	112	128	144	160	176	192	208	224	240	256	272	288	304	320
8 x 16	64	85+	107-	128	149+	171-	192	213+	235-	256	277+	299-	320	341+	363-	384	405+	427-
° 10 x 10	50	67-	83+	100	117-	133+	150	167-	183+	200	217-	233+	250	268-	283+	300	317-	333+
10 x 12	60	80	100	120	140	160	180	200	220	240	260	280	300	320	340	360	380	400
12 x 12	72	96	120	144	168	192	216	240	264	288	312	336	360	384	408	432	456	480
12 x 14	84	112	140	168	196	224	252	280	308	336	364	392	420	448	476	504	532	560
14 x 14	98	131-	163+	196	229-	261+	294	327-	359+	392	425-	457+	490	523-	555+	588	621-	653+
* 6 x 18	54	72	90	108	126	144	162	180	198	216	234	252	270	288	306	324	342	360
° 8 x 18	72	96	120	144	168	192	216	240	264	288	312	336	360	384	408	432	456	480

NOTE :- + or - means + or - $\frac{1}{3}$ B.F. (For instance$^+$) exact 853.33

APPROVED Jan. 1, 1956
Scott P. Hart
STATE HIGHWAY ENGINEER

Montana State Highway Commission

REV. 10-1-51

TABLE OF EQUIVALENTS OF INCHES AND FRACTIONS OF INCHES IN DECIMALS OF A FOOT

INCHES	0	1/8	1/4	3/8	1/2	5/8	3/4	7/8
0	0	.0104	.0208	.0313	.0417	.0521	.0625	.0729
1	.0833	.0938	.1042	.1146	.1250	.1354	.1458	.1563
2	.1667	.1771	.1875	.1979	.2083	.2188	.2292	.2396
3	.2500	.2604	.2708	.2813	.2917	.3021	.3125	.3229
4	.3333	.3438	.3542	.3646	.3750	.3854	.3958	.4063
5	.4167	.4271	.4375	.4479	.4583	.4688	.4792	.4896
6	.5000	.5104	.5208	.5313	.5417	.5521	.5625	.5729
7	.5833	.5938	.6042	.6146	.6250	.6354	.6458	.6563
8	.6667	.6771	.6875	.6979	.7083	.7188	.7292	.7396
9	.7500	.7604	.7708	.7813	.7917	.8021	.8125	.8229
10	.8333	.8438	.8542	.8646	.8750	.8854	.8958	.9063
11	.9167	.9271	.9375	.9479	.9583	.9688	.9792	.9896

MONTANA STATE HIGHWAY COMMISSION

APPROVED Jan. 1, 1956
STATE HIGHWAY ENGINEER

REV. 1-1-56

DECIMAL EQUIVALENTS OF INCHES FOR SURFACING THICKNESSES

CONVERSION EQUIVALENTS INCHES TO FEET	
1 in.	0.10 ft.
2 in.	0.15 ft.
2½ in.	0.20 ft.
3 in.	0.25 ft.
4 in.	0.35 ft.
5 in.	0.40 ft.
6 in.	0.50 ft.
7 in.	0.60 ft.
8 in.	0.70 ft.
9 in.	0.75 ft.
10 in.	0.85 ft.
11 in.	0.90 ft.
12 in.	1.00 ft.

APPROVED Jan. 1 1956
Scott P. Hart
STATE HIGHWAY ENGINEER

Montana State Highway Commission

1-1-56

CONCRETE REINFORCING STEEL BARS

BAR SIZES		WEIGHT POUNDS PER FOOT	NOMINAL DIMENSIONS-ROUND SECT.		
OLD (INCHES)	NEW (NUMBER)		DIAMETER INCHES	CROSS SECT. AREA-SQ. INCH.	PERIMETER INCHES
1/4	2	.167	.250	.05	.786
3/8	3	.376	.375	.11	1.178
1/2	4	.668	.500	.20	1.571
5/8	5	1.043	.625	.31	1.963
3/4	6	1.502	.750	.44	2.356
7/8	7	2.044	.875	.60	2.749
1	8	2.670	1.000	.79	3.142
1	9	3.400	1.128	1.00	3.544
1 1/8	10	4.303	1.270	1.27	3.990
1 1/4	11	5.313	1.410	1.56	4.430

The new bar numbers are based on the number of 1/8 inches included in the nominal diameter of the bar.

Bar number 2 in plain rounds only. Bars numbered 9, 10 and 11 are round bars and equivalent in weight and nominal cross-sectional area to the old type 1", 1-1/8" and 1-1/4" square bars.

The above weights were adopted as standards by the Institute in 1934 and supersede former practice.

These weights have been approved through the U.S. Department of Commerce Simplified Practice Recommendation R 26-50

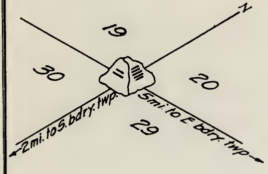
APPROVED Jan. 1, 1956
Scott P. Hart
STATE HIGHWAY ENGINEER

Montana State Highway Commission.

REV. 1-1 - 56

MARKS ON STONE MONUMENTS

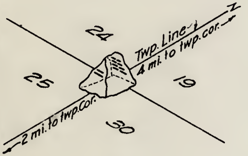
Stone corners may be notched on edges, or grooved on faces depending on how stone is set in relation to cardinal points. For convenience, illustrations below show grooves.



INTERIOR CORNER

COMMON TO FOUR SECTIONS

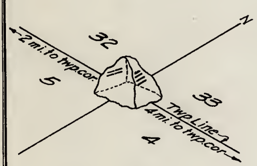
Number of grooves on East and South faces indicates number of miles from East and South boundaries of the township.



EXTERIOR CORNER

COMMON TO FOUR SECTIONS ON N.&S. TOWNSHIP LINE

Number of grooves on North and South faces indicate number of miles from corresponding township corners.



EXTERIOR CORNER

COMMON TO FOUR SECTIONS ON E.& W. TOWNSHIP LINE

Number of grooves on East and West faces indicates number of miles from corresponding township corners.

Where ties are to be made to land corners, the field party should have a copy of the U.S.G.L.O. notes pertaining to same.

The topography, description of corners and markings, bearing trees and courses contained therein are indispensable for identifying old corners.

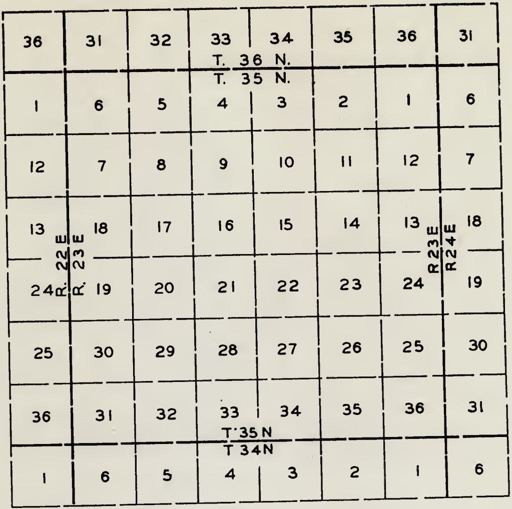
For markings used in special cases such as closing corners, meander corners, witness corners, etc., see Manual of Instructions for Survey of Public lands issued for the U.S.G.L.O.

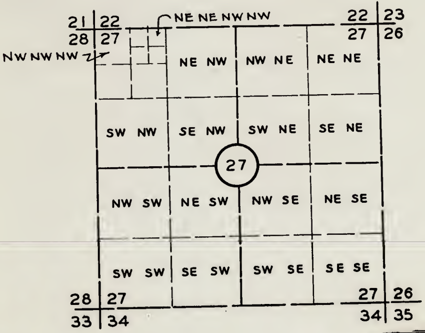
All locators and R/W field men should be familiar with means of identifying corners and also with legal procedure for reestablishing lost and obliterated corners.

APPROVED Jan. 1, 1956
Geo. P. Hart
STATE HIGHWAY ENGINEER

REV. 10-1-51

SECTION AND TOWNSHIP PLATS



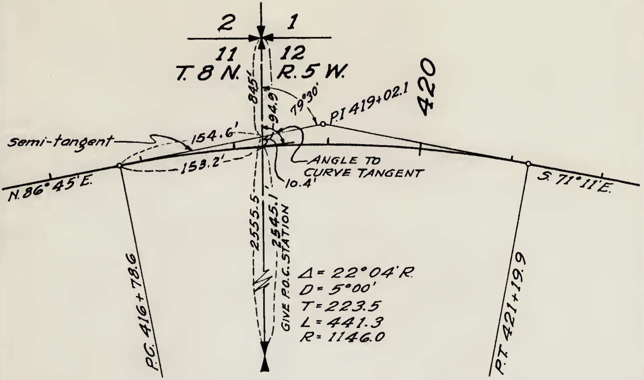


APPROVED Jan. 1, 1936
Scott P. Hart
STATE HIGHWAY ENGINEER

Montana State Highway Commission.

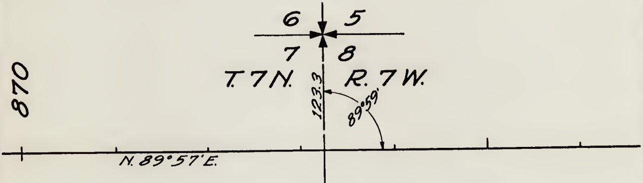
REV. 10-1-51

TIE TO SECTION LINE ON CURVE



Describe in detail type of corner tied to.

TIE TO SECTION LINE ON TANGENT



APPROVED Jan. 1 1956
Scott P. Hart
STATE HIGHWAY ENGINEER

REV. 10-1-51

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SC

WITNESS MONUMENTS FOR CORNERS

METHODS OF WITNESSING CORNERS WHICH WOULD BE DESTROYED BY HIGHWAY CONSTRUCTION

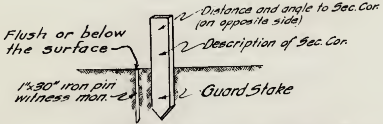
Corners to be witnessed where ever possible by 4 monuments so that original point can be located by intersecting alone. Where the lay of the land or obstructions is such as to prohibit the intersection method, not less than 2 monuments are to be used in tying the corner. The engineer will be expected to exercise his best judgment in selecting the position for witness corners with a view to affording definite and convenient connections from the witness corners to the true point for the monument.

When corner is in fill, cover corner and record as shown in example.

When corner is in cut, reset corner from witness monuments, placing same at least 12 inches below road surface and record depth in notes.

Where ever possible place witness monuments 1 ft. inside R/W lines.

Notes, accompanied by sketch, are to be filed in the office of the County Clerk and Recorder and copy of same to be sent to the office of the Cadastral Engineer in Billings and the general office of the State Highway Commission in Helena.


Distance and angle to Sec. Cor. (on opposite side)
Flush or below the surface
Description of Sec. Cor.
1"x30" iron pin witness mon.
Guard Stake

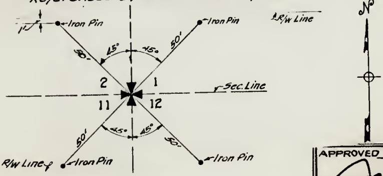
SKETCH SHOWING METHOD OF MARKING & PLACING GUARD STAKES

Terry, Mont.
Aug. 2, 1935

I hereby certify that the section corner of Section 1-2-11 and 12, T29N - R45E MPM is covered by highway embankment 4 ft. in depth, that the corner is referenced with iron pins 1" x 30" set at the angles and distances as shown and that guard stakes, giving description of corner, angles and distances as set adjacent to each reference monument.

Tom Smith
Project Engineer
Montana State Highway Comm.

EXAMPLE
PUBLIC ( ) SURVEY MONUMENT
Corner to Sections 1-2-11-12 T29N-R45E
Referenced by Tom Smith Aug. 2, 1935

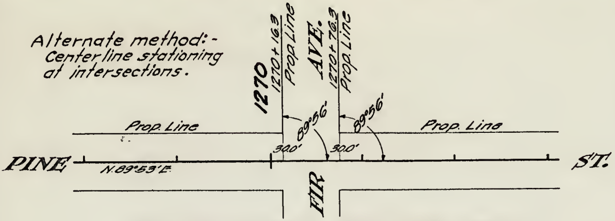


APPROVED Jan. 1, 1936
Scott P. Hart
STATE HIGHWAY ENGINEER

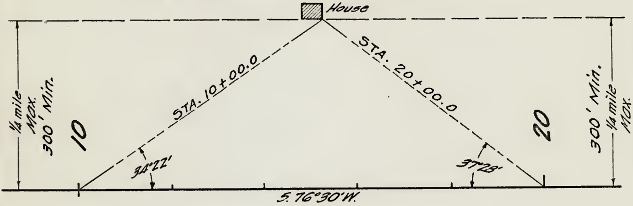
Montana State Highway Commission

REV. 10-1-51

TIES TO MUNICIPALITY LINES

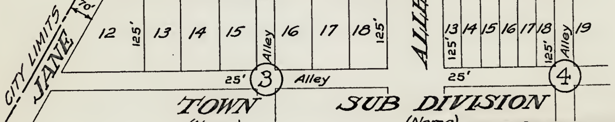


TIE FOR TOPOG. TOO FAR FROM LINE TO CHAIN CONVENIENTLY



TIE TO CITY OR TOWN LIMITS

Legal description of city or town to be submitted with location survey notes.

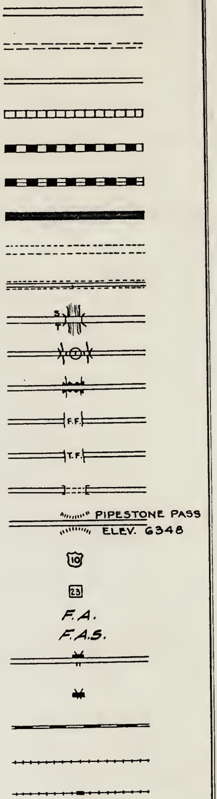


APPROVED Jan. 1, 1956
Scott P. Hart
STATE HIGHWAY ENGINEER

REV. 1-30-52
REV. 1-1-56

CONVENTIONAL SIGNS (CONTRACT PLANS)

PRIMARY ROADS .08 INCH WIDE
ALL OTHERS .05 INCH WIDE
PRIMITIVE ROADS
UNIMPROVED ROADS
GRADED ROAD
GRAVELED ROAD
OILED ROAD
PAVED ROAD (BRICK OR CONC.)
FED. AID ROUTING (NON-EXISTENT ROAD).
FED. AID ROUTING (ON EXISTING ROAD)
HIGHWAY BRIDGE (OVER 20' CLEAR SPAN).
W = WOOD, S = STEEL, C = CONCRETE (ABOVE)
T = TRUSS, G = GIRDER (BELOW).
DRAWBRIDGES
ARCHBRIDGES
FREE FERRIES
TOLL FERRIES
HIGHWAY TUNNELS
PASS
U.S. HIGHWAYS
STATE HIGHWAYS
FED. AID SYSTEM
FED. AID SECONDARY SYSTEM.
DAM WITH ROAD
DAM WITHOUT ROAD
RAILROAD (LARGE SCALE MAPS).
RAIL ROAD (SMALL SCALE MAPS).
RAILROAD STATIONS



APPROVED Jan. 1, 1956
Scott P. Hart
STATE HIGHWAY ENGINEER

Montana State Highway Commission

REV. 10-1-51

CONVENTIONAL SIGNS (CONTRACT PLANS)

RAILROAD CROSSING

RAILROAD ABOVE

RAILROAD BELOW

PRIVATELY OWNED RAILROAD

CATTLE GUARDS

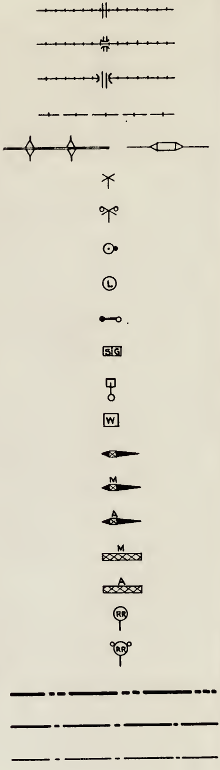
FOR RAILROAD CROSSING PROTECTION

- SIGNS (PLAIN)
- SIGNS (REFLECTOR).
- BELLS
- LIGHTS (STATIONARY).
- LIGHTS (FLASHING)
- LIGHTS (STOP & GO).
- WIG WAG
- WATCHMAN
- GATES (NOT CLASSIFIED)
- GATES (MANUAL)
- GATES (AUTOMATIC).
- BARRIERS (MANUAL)
- BARRIERS (AUTOMATIC).
- APPROACH WARNING SIGNS (PLAIN)
- APPROACH WARNING SIGNS (REFLECTOR).

STATE & NATIONAL LINE

COUNTY LINE

CITY, VILLAGE OR BOROUGH LINE



Montana State Highway Commission

APPROVED Jan. 1, 1956
Fred P. Hart
STATE HIGHWAY ENGINEER

REV. 10-1-51

CONVENTIONAL SIGNS (CONTRACT PLANS)

Used on Hwy. Plan sheets.
- TOWNSHIP LINE
- SECTION LINE (Showing Corner) Solid, if found. Open, if not found
- RESERVATION LINE

FENCE LINE

RAIL FENCE

GUARD RAIL

GUIDE POSTS

SNOW FENCE

UNFENCED PROPERTY

R/W LINE

R/W LINE (FENCED)

R.R. R/W (FENCED)

R.R. R/W (UNFENCED)

BASE OR SURVEY LINE

℄ OF STAKED LINE WHEN A PROJ. IS MADE

TRAVELED WAY

LEVEE

RETAINING WALL

CULVERTS IN PLACE

NEW CULVERTS (PLAN)

NEW CULVERTS (PROFILE).

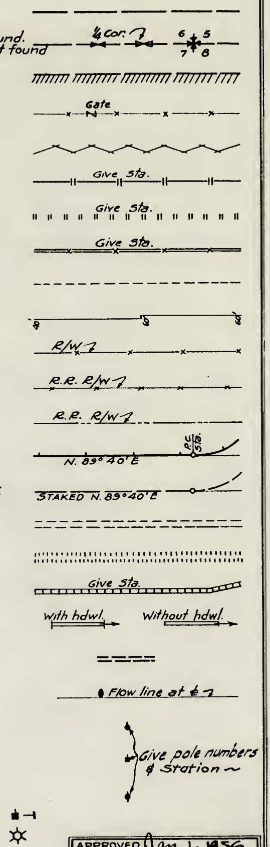
TROLLEY POLE

POWER POLE

TELEPHONE POLE

POLE, GUY WIRE & ANCHOR

LIGHT POLE



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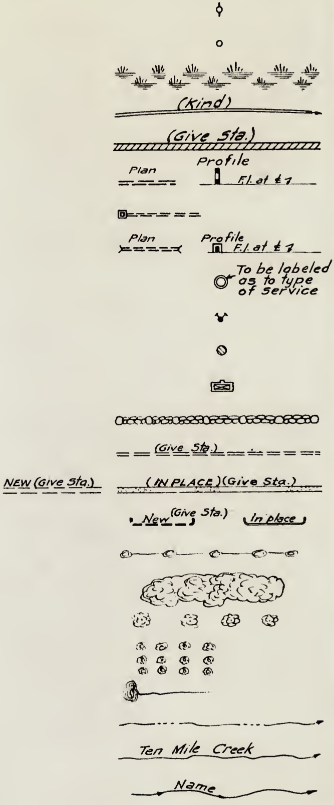
STATE HIGHWAY ENGINEER

Montana State Highway Commission.

REV. 10-1-51

CONVENTIONAL SIGNS (CONTRACT PLANS)



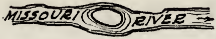
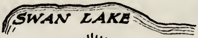
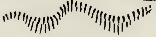
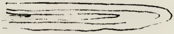
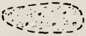
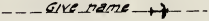
TELEGRAPH POLE	
GUY POLE	
MARSH, SWAMP	
DITCH	(Kind)
RIPRAP	(Give Sta.)
IRR. SYPHON	Plan Profile F.L. at ℄
DROP INLET OR CATCH BASIN	
CONC. BOX CULVERT	Plan Profile F.L. at ℄
MANHOLE	To be labeled as to type of service
HYDRANT	
WELL	
SCALES	
STONE WALL	
FOOT PATH	(Give Sta.)
CONC. SIDEWALK	NEW (Give Sta.) (IN PLACE)(Give Sta.)
CONC. CURB	New (Give Sta.) In place
HEDGE	
HEAVY TIMBER, WOODS	
SEPARATE TREES	
ORCHARD	
SPRING	
INTERMITTENT STREAM	
SMALL CREEK	Ten Mile Creek
IRRIGATION CANAL	Name

APPROVED Jan. 4, 1956
Scott P. Hart
STATE HIGHWAY ENGINEER

Montana State Highway Commission

REV. 10-1-51

CONVENTIONAL SIGNS (CONTRACT PLANS)

RIVERS, LARGE CREEKS.	
LAKE	
BLUFFS OR CLIFFS	
GULCH	
GRAVEL PIT.	
AIR ROUTE	
CIVIL AERONAUTICS AUTHORITY INTERMEDIATE AIR FIELD	⌖
COMMERCIAL OR MUNICIPAL AIR FIELD	☼
MARKED AUXILIARY AIR FIELD	+
LETTER "B" INDICATES HOUSING FACILITIES	Ⓑ
GOLF GROUND OR COUNTRY CLUB	☐ C. OR G.
FAIR GROUNDS	⬭
CEMETERY	[+]
INCORPORATED TOWN	#
STATE CAPITAL	⊛
COUNTY SEAT	◉
OTHER TOWNS	○
FARM UNIT	■
DWELLING	◪
GROUPS OF DWELLINGS	▬
SMALL BUSINESS ESTABLISHMENT	▙
GROUP OF SMALL BUSINESS ESTABLISHMENTS	▙⁴
TOWN HALL	☗

APPROVED Jan. 1, 1956
Scott P. Hart
STATE HIGHWAY ENGINEER

REV. 10-1-51

CONVENTIONAL SIGNS (CONTRACT PLANS)

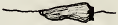
CHURCH	⛪
SCHOOLHOUSE	▮
CORRECTIONAL INSTITUTION	▥
INDUSTRIAL PLANT	▙
BEET DUMP	⏶
CAMP OR LODGE	▲
RANGER OR GUARD STATION	▀
LOOKOUT STATION	◉
SAWMILL	⏶
CAMPGROUND	▲
SEASONAL OR SUMMER COLONY DWELLING	◣
GROUP OF SEASONAL OR SUMMER COLONY DWELLING.	◣◣
MINE, QUARRY OR OPEN CUT	⚒
OIL OR GAS WELL	ஃ
TANKS	⊘
POWER PLANT	■
FORT	⌑
RADIO STATION	▮ KXLJ
GARBAGE DUMP	◫
STATE ROAD GARAGE	⊠
GAME FARM OR FISH HATCHERY	⯊
U.S. PORTS OF ENTRY	✠
STATE COURTESY STATION	☆
STATE COURTESY STATION WITH PIT SCALES	★

APPROVED Jan. 4, 1956
Scott P. Hart
STATE HIGHWAY ENGINEER

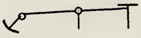
Montana State Highway Commission

REV. 10-1-51

CONVENTIONAL SIGNS (CONTRACT PLANS)

CAMPS	Boy Scout
GAUGING OR PUMPING STATION	⊖
PROMINENT PEAK	Granite 12,850
GLACIER	
RESERVOIR WITH DAM	
PROJECT MARKER	⊞
STATION MARKER	⊗
R/W MONUMENT	◊
IRON PIN, IRON PIPE OR HUB & TACK	• I.P. or H.T.
LIGHT CABLE	-- L.C. ---- L.C. ---
TELEPHONE OR TELEGRAPH CABLE	-- TELEPHONE- OR -TELEG. --
WATER LINE	--- W ----- W. ---
SEWER LINE (STORM OR SANITARY)	-- S ----- S ---
NATURAL GAS LINE	-- N.G. ---- N.G. ---
GASOLINE OR OIL LINE	-- GASOLINE OR OIL --

CONVENTIONAL SIGNS FOR USE ON CROSS SECTIONS.

POWER POLE (No. of Wires & Voltage)	
TELEPHONE POLE (No. of Wires & Voltage)	T
TELEGRAPH POLE (No. of Wires & Voltage)	T
GUY POLE	
ANCHOR & POLE BRACE	

APPROVED Jan. 1 1936
Scott P. Hart
STATE HIGHWAY ENGINEER

Montana State Highway Commission

REV. 4-1-48
REV. 10-1-51

Griffith

STATE HIGHWAY COMMISSION
HELENA, MONTANA

MEMORANDUM

TO: ALL BOOK HOLDERS

FROM: FRED QUINNELL, JR. State Highway Engineer

SUBJECT: STANDARDS

Enclosed please find loose sheets of new or revised standard drawings. These are to replace or add to those now in your book.

Fred Quinnell Jr.
FRED QUINNELL, JR.

FQ
MRW:cas
Enc.

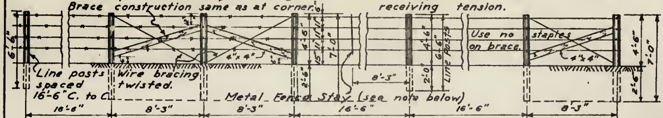
STD. DWG. NO. 31
RWF

RIGHT OF WAY FENCE

4 WIRE FENCE (TYPE F—4)

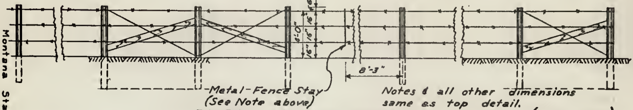
Stretching Post 1320' Maximum from corner post or as required by ground line. Brace construction same as at corner.

Brace corner & gate posts as below. Corner posts to be braced on all sides receiving tension.

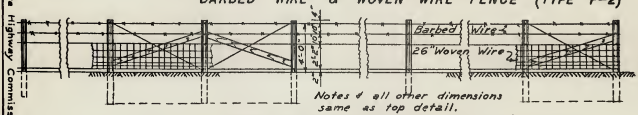


Note: stays to be used when Type F-3 or F-4 Fence is placed on Interstate Highways.

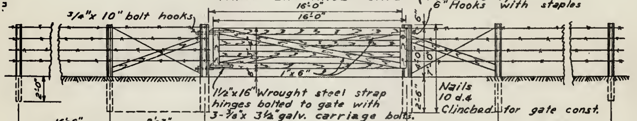
3 WIRE FENCE (TYPE F—3)


6"
4'-0"
16"
16"
16"
8'-3"
Metal-Fence Stay (See Note above)
Notes & all other dimensions same as top detail.

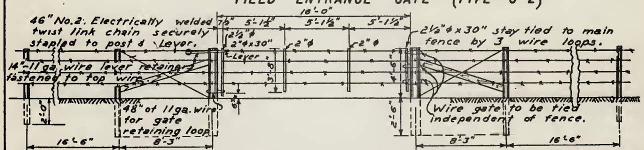
BARBED WIRE & WOVEN WIRE FENCE (TYPE F—2)



FARM ENTRANCE GATE (TYPE G-1)


16'-0"
16'-0"
3/4"x 10" bolt hooks
6" Hooks with staples
6"
1"x 6"
4'-0"
2'-0"
1½"x16" Wrought steel strap hinges bolted to gate with 3-⅜"x 3½" galv. carriage bolts.
2'-6"
Nails 10 d.4 Clinched for gate const.
16'-6"
8'-3"
8'-3"
16'-6"

FIELD ENTRANCE GATE (TYPE G-2)


16'-0"
7½"
5'-1½"
5'-1½"
5'-1½"
46" No.2. Electrically welded twist link chain securely stapled to post & Lever.
2½"φ
2"φx30"
2"φ
2"φ
Lever
2½"φ x 30" stay tied to main fence by 3 wire loops.
14"-11 ga. wire lever retainers fastened to top wire.
3'-8"
4'-6"
6"
2'-0"
48" of 11ga. wire for gate retaining loop
2'-6"
Wire gate to be tied independent of fence.
16'-6"
8'-3"
8'-3"
16'-6"

POSTS: When steel posts are used, they shall be the same length as specified hereon for wood posts. For arrangement of steel post brace assembly see std. DWG. NO. 34 RWF.

LUMBER: Full sawed Montana Larch, or Montana or Pacific Coast Douglas Fir. Braces may also be constructed of peeled round poles of a minimum diameter of 4½".

Leaning fence may be substituted if approved in writing by the Engineer.

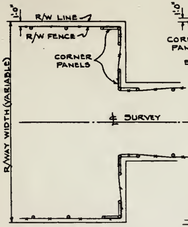
Steel End, gate and corner posts and braces shall be imbedded in Class "F" concrete in a manner similar to the illustration on Standard Drawing No.34 RWF.

APPROVED JAN. 17, 1958
Fred Quinnell
STATE HIGHWAY ENGINEER

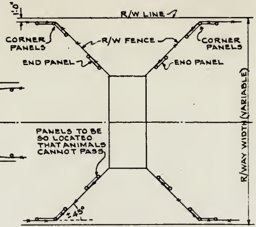
REV. 4-3-58
REV. 6-17-58

Montana State Highway Commission.

COMBINATION BARBED AND WOVEN WIRE FENCE

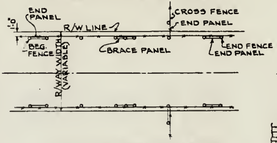


PLAN OF FENCE AT CHANGE IN R/W WIDTH

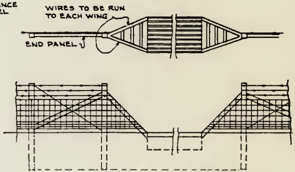


PLAN OF FENCE AT DRAINAGE STRUCTURE OR STOCK PASS

NOTE: ALL FENCE WIRE TO BE PLACED ON PASTURE SIDE OF POSTS EXCEPT ON CURVES THE WIRE SHALL BE PLACED ON THE OUTSIDE OF THE CURVE.

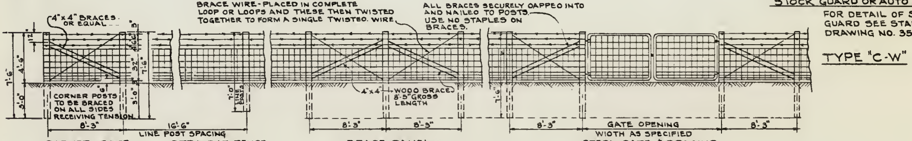


PLAN OF STRAIGHT FENCE AND CROSS FENCE CONNECTION.



FENCE CONNECTION TO STOCK GUARD OR AUTO GATE

FOR DETAIL OF STOCK GUARD SEE STANDARD DRAWING NO. 35-SG.


4"x4" BRACES OR EQUAL
BRACE WIRE-PLACED IN COMPLETE LOOP OR LOOPS AND THESE THEN TWISTED TOGETHER TO FORM A SINGLE TWISTED WIRE.
ALL BRACES SECURELY DAPPED INTO AND NAILED TO POSTS. USE NO STAPLES ON BRACES.
1½"
3"
4'-6"
7'-6"
3'-0"
4@6"
3@2"
7'-6"
3'-0"
3"
6"
CORNER POSTS TO BE BRACED ON ALL SIDES RECEIVING TENSION
7'-0" LINE POSTS
4"x4"
WOOD BRACE 8'-5" GROSS LENGTH
7'-6"
8'-3"
16'-6"
LINE POST SPACING
8'-3"
8'-3"
8'-3"
GATE OPENING WIDTH AS SPECIFIED
8'-3"
TYPE "C-W"

CORNER, GATE OR END PANEL

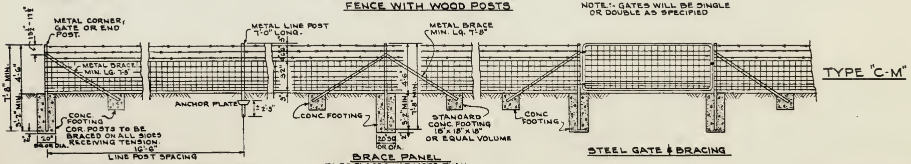
STRAIGHT FENCE

BRACE PANEL
TO BE PLACED NOT MORE THAN 990'-0" APART.

STEEL GATE & BRACING

FENCE WITH WOOD POSTS

NOTE:- GATES WILL BE SINGLE OR DOUBLE AS SPECIFIED


METAL CORNER, GATE OR END POST.
10½"-11½"
METAL LINE POST 7'-0" LONG.
METAL BRACE MIN. LG. 7'-8"
METAL BRACE MIN. LG. 7'-8"
7'-8" MIN.
4'-6"
3'-2" MIN.
4@6"
32"
3"
ANCHOR PLATE
±2'-3"
CONC. FOOTING
CONC. FOOTING
COR. POSTS TO BE BRACED ON ALL SIDES RECEIVING TENSION.
2"
20"
9" OR DIA.
16'-6"
LINE POST SPACING
CONC. FOOTING
4'-6"
7'-8" MIN.
3'-2" MIN.
20"SQ OR DIA.
STANDARD CONC. FOOTING 18"x18"x18" OR EQUAL VOLUME
CONC FOOTING
TYPE "C-M"

CORNER, GATE OR END PANEL

STRAIGHT FENCE

BRACE PANEL
TO BE PLACED NOT MORE THAN 990'-0" APART.

STEEL GATE & BRACING

FENCE WITH STEEL POSTS

NOTE:- ALL TYPES OF "PANELS" SHALL BE DESIGNATED AS "FENCE PANELS" IN THE PROPOSAL AND CONTRACT.

REV. 9-21-58
REV. 6-17-58
11-12-57

Montana State Highway Commission

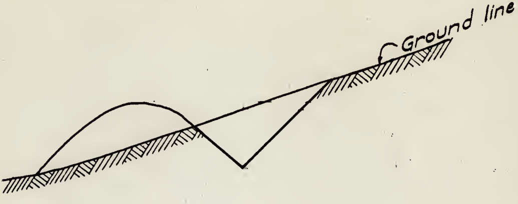
APPROVED NOV. 14, 1957

STATE HIGHWAY ENGINEER

34 RWF

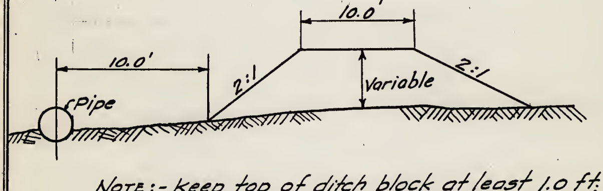
FURROW DITCH & DITCH BLOCK

FURROW DITCH



Furrow Ditches shall be constructed wherever possible as directed by the Engineer.
The unit of measurement shall be the cubic yard.
Quantities will be included in the payment for Unclassified Excavation.
Depth of the furrow ditch will be as directed by the Engineer.

DITCH BLOCK



Note:- keep top of ditch block at least 1.0 ft. below finished shoulder elevation and toe of slope flow 10.0' from pipe.

Montana State Highway Commission.

APPROVED JAN 17, 1958
STATE HIGHWAY ENGINEER

REV. 10-1-51
REV. 5-21-58

STD. DWG. NO. 171
SN

STANDARD SUMMARY NOTES

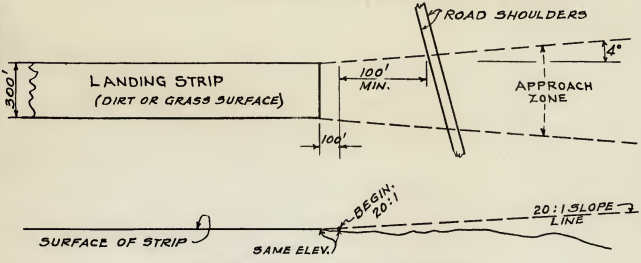
GRADES	For relation of profile grade to sub-grade see typical section.
EMBANKMENT	Quantities shown on plans include shrinkage, unless otherwise noted.
SHRINKAGE	See Std. 242-SF & 243-SF1
BORROW	Borrow pits or source of borrow shown on plans, or as designated by Engr.
OVERHAUL	Free haul limit is 1000' feet.
SURPLUS	Surplus or excess to be disposed of as shown on plans or Spec. Provisions.
WIDENING	See Std. 231-G5
SUPERELEVATION	See Std. 231-G5
PROJECTIONS	All projections to be checked in field with reference to the staked line.
FURROW DITCH	See Standard Dwg. No. 151-FD.

Montana State Highway Commission.

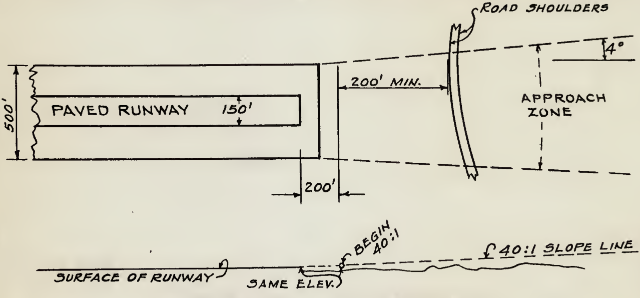
APPROVED JAN 17, 1958
STATE HIGHWAY ENGINEER

REV. 5-21-58 REV. 10-1-51
REV. 1-1-56

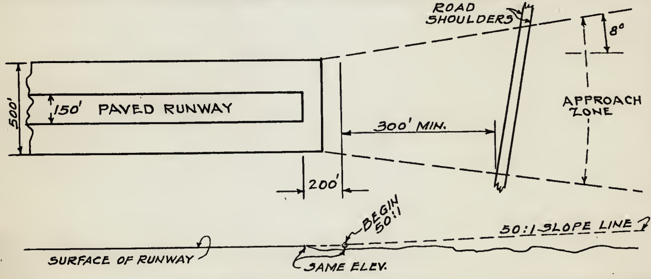
AIRPORT - HIGHWAY CLEARANCE.



GENERAL SMALL AIRPORT



PAVED RUNWAY-NON INSTRUMENT



PAVED RUNWAY - INSTRUMENT

NOTE:- THE SLOPE LINE, IN ALL CASES, MUST CLEAR OR BE ABOVE THE NEAR ROAD SHOULDER AT LEAST 15 FEET.

APPROVED 3-26-58
Fred Quinnell
STATE HIGHWAY ENGINEER
3-26-58

Montana State Highway Commission.